Appellant reference: NA/3UK/MAN19864/APPEAL

LPA application reference: 133822/TEL/2022

Section 78 of the Town and Country Planning Act 1990 (as amended)

Appeal Statement

On behalf of

Hutchison 3G UK Ltd.

A planning appeal by written representation against the decision of Manchester City Council to refuse planning consent for the installation of telecommunications apparatus at Cringle Hall Road, Burnage, Manchester, M19 2JE.

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Section 1: Introduction

1. This statement has been prepared by Dalcour Maclaren (hereinafter referred to as "the Agent"), acting for Hutchison 3G UK Ltd who will hereinafter be referred to as "the Appellant". It should be noted at this juncture that Hutchison 3G UK Ltd are commonly known as "H3G" or "Three UK", a Mobile Network Operator (MNO). The appeal is brought by the Appellant against the refusal of Prior Approval by Manchester City Council (hereinafter referred to as "the Local Authority") for the proposed deployment of telecommunications development at Cringle Hall Road, Burnage, Manchester, M19 2JE ("the Appeal site").

2. On 19th May 2022, the Appellant, via the Agent, submitted an application to the Local Authority for Prior Approval to install a 15m telecommunications monopole supporting antennas; ground-based equipment cabinets, and ancillary development thereto. The application was decided via delegated powers, and by notice dated 8th July 2022, the Local Authority confirmed that Prior Approval had been refused for the following reasons:-

> *"The City Council is not satisfied that this development has been sited and designed to minimise the impact upon visual amenity. The proposed telecommunication installation by reason of its height, siting and appearance, would be unduly harmful to the character and visual amenity of the streetscene and nearby residential properties, as well as the adjacent green space off Cringle Hall Road. The proposed telecommunications equipment would therefore be contrary to policies DM1 and SP1 of the Manchester Core Strategy (2012), saved policy DC17.1 of the Unitary Development Plan for the City of Manchester (1995) and the National Planning Policy Framework (NPPF)".*

3. The Appellant submits that the Local Authority's decision to refuse Prior Approval based on the above reasoning and alleged policy conflict is not defensible. This statement will provide background information about the Appellant's networks and their requirements for the proposed development at the appeal site. It will assess the appeal proposal against planning policy and will demonstrate that Prior Approval should have been given based on policy compliance and the fact that the appeal proposal represents a wholly acceptable development. On this basis, it will be concluded that the decision to refuse Prior Approval is not defensible and should not be upheld.

Section 2: The Appeal Site And Proposal

4. The appeal site is located on the northern pedestrian footway of Cringle Hall Road, close to the junction with Slade Lane, Burnage, Greater Manchester. The footway runs adjacent to a small area of grass land which accommodates two mature trees, which measure approximately 7.5m and 10m, in height, respectively.

5. The surrounding area is typical of a city suburb, with two-storey residential properties evident in all directions. These properties line the local road network in a grid-like fashion, with each property

bookended by both a front and rear garden/drive. To the north west of the appeal site lies Cringle Brook Primary School, and, immediately to the east of the appeal site (on Slade Lane) is a run of commercial and retail units including a Solicitors Office, a local Cost-Cutter Convenience Store, plus a restaurant/takeaway. These units are situated on the ground-floor of the two-storey properties on this section of Slade Lane. There is intermittent tree cover along both Slade Lane and Burnage Lane which assists in filtering medium- and long-range views along these highways. These trees are mature in both height and age, and are positioned on the pedestrian footways, and on the border of private residential properties.

6. The local road network accommodates the typical amount of street furniture for a suburban area, with street lighting columns, traffic light columns, road traffic signs, bus shelters, and wooden telegraph poles accommodating overhead power lines all evident.

7. Whilst the appeal site does not sit within a Conservation Area.



Figure 1 – Location of Appeal Site, identified via a red box (Source: Google Streetview)

8. As can be seen in Figure 1, the appeal site has been specifically positioned to ensure that it does not sit directly opposite a residential property, to therefore minimise any perceived visual impact of the scheme.

9. As shown in Figure 2, below, the most visible piece of infrastructure – the monopole – is positioned as the most easterly of the apparatus, to ensure that it is as close to the junction as possible, without impacting visibility splays, to ensure that the maximum distance between the monopole and the nearest residential property is achieved.

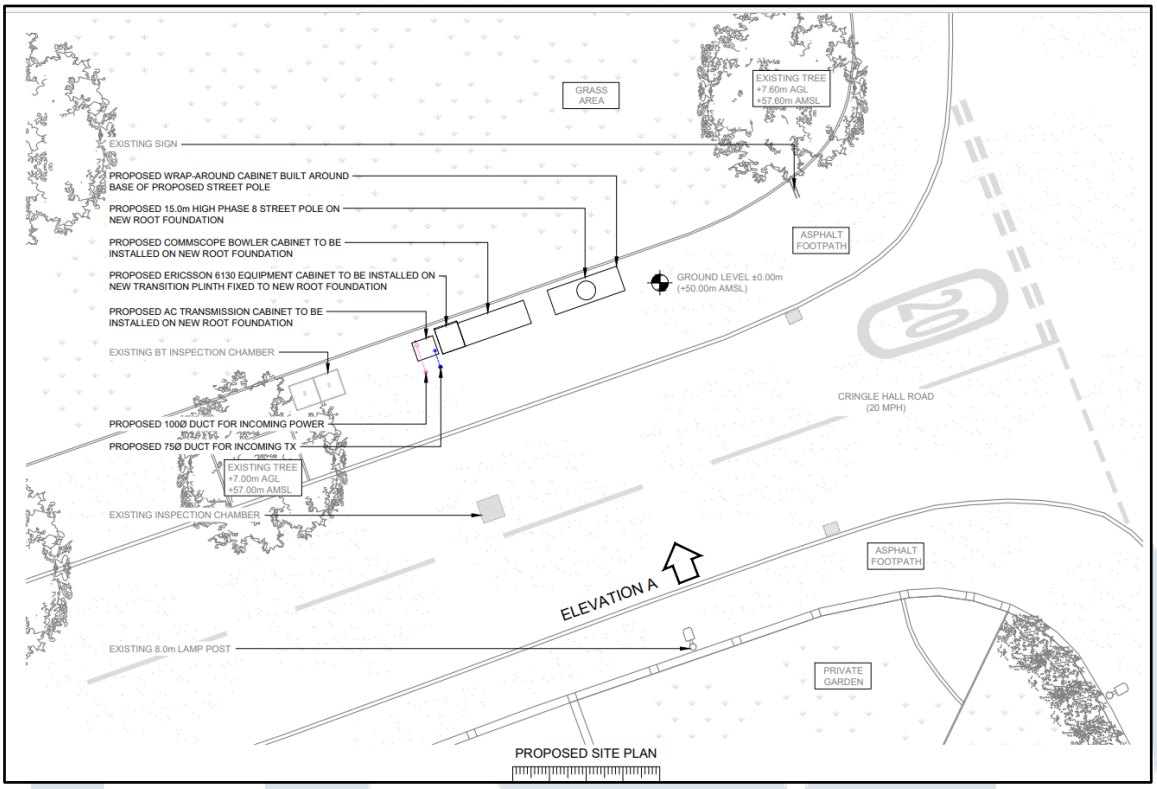


Figure 2 – Proposed Site Plan (as submitted with application 133822/TEL/2022)

10. Whilst the Appellants acknowledge that views of the appeal site will be achievable from residential properties within the immediate vicinity, the impact on these views has been minimised, as far as practicable, by the proposed positioning of the appeal scheme and the use of the existing mature tree cover within the immediate proximity of the appeal site. Furthermore, the Appellants submit that the apparatus proposed as part of the appeal scheme is now commonplace in all settings – be it residential, suburban, commercial, retail, or industrial. The apparatus is designed to serve a particular function, and must be close to the target area in order to provide this service.

11. Given the nature of the surrounding area, i.e. densely-packed residential properties, it is submitted that the best town planning and environmental solution has been brought forward as part of the appeal scheme, with every effort made to minimise any perceived visual impact, as far as practicable, on the surrounding area, or on the residential properties within the locale.

Relevant Planning History

12. There is no relevant planning history relating to the appeal site.

Appeal Proposal

13. The appeal scheme proposes the deployment of a new base station on the northern pedestrian footway of Cringle Hall Road. The monopole measures 15m (to top height), and will be supported by three ground-based equipment cabinets, plus one wraparound cabinet at the base of the monopole. The new, innovative monopole design allows the antennas to be 'stacked' and positioned within a linear structure, rather than a wider, shrouded headframe – as was typically the case with traditional telecommunications monopoles over the last two decades. This has allowed the traditional 'bubble' headframe monopoles to be dispensed with, and replaced within the streetscene by designs similar to the appeal scheme. This ensures that the appeal structure is the smallest, and thinnest, it can be, without compromising the operational efficiency of the base station. This relatively new design option is considered to be preferable, from an environmental and town planning perspective, to the traditional shrouded monopoles that were typically located adjacent to the public highway, or within suburban areas. The type of structure proposed as part of the appeal scheme is now common across the UK.

14. The wraparound cabinet is also a new, innovative design, which minimises the length of the cabinet 'run' along the footway.

15. The H3G coverage, capacity and connectivity that will be provided from the appeal scheme will service the surrounding area of Burnage, with 3G, 4G and 5G services being provided to local residents and businesses for the first time.

16. A site search was undertaken within the local area to identify a suitable location to accommodate a new base station that would provide new network coverage to the local area. The appeal site is considered to offer the optimum solution.

17. As outlined within the Supplementary Information document that accompanied the original submission, 3no ground-based equipment cabinets are required. These cabinets, however, do not form part of the application as they are permitted by Class A of Part 16, Schedule 2 of the GPDO 2022 (as amended). Despite the fact that these cabinets do not form part of the application, their types and dimensions were included as part of the appeal submission and to ensure clarity as to what level of equipment will be deployed as part of the appeal scheme.

18. The appeal scheme will provide 3G, 4G and 5G mobile network coverage for H3G and will provide new mobile services across the surrounding area, leading to numerous social, economic, and environmental public benefits.

Section 3: Assessment Of The Reasons For Refusal

19. The Local Authority's Decision Notice sets out the reasons that planning consent was refused (see paragraph 2, above). The Local Authority assessed that the appeal scheme would be unsuitable owing to its "*height, siting and appearance*" and would be "*unduly harmful to the character and visual amenity of the streetscene and nearby residential properties, as well as the adjacent green space off Cringle Hall Road*".

20. The Decision Notice also referred to policies DM1 and SP1 of the Manchester Core Strategy (2012), saved policy DC17.1 of the Unitary Development Plan for the City of Manchester (1995), and the National Planning Policy Framework (NPPF), with the Local Authority stating that the appeal scheme would conflict with all of these policies.

21. The Officers Delegated Report provides further details on the reasons for refusal given within the Local Authority's Decision Notice. Whilst the Local Authority's grounds for refusal will be challenged within the remainder of this document, is it submitted that the inclusion of the incorrect information within the Officers Delegated Report is evidence that the Local Authority did not give due care and attention to the original submission or the assessment of the scheme, having seemingly either referred to a different scheme altogether, or written over an old template.

22. On page 3 of the Officers Delegated Report, it states:

> "*The development can be assessed, under this legislation as:*
> *- The existing building is between 15 and 30 metres high and the height of the equipment, taken by itself, would be 7.95 metres and therefore would be less than 8 metres.*
> *- There would be no more than 5 antenna systems on the building (whilst there would be 8 antennas, in total, on the building, the legislation describes an antenna system as a set of antennas installed on a building and does not therefore restrict permitted development rights to 5 individual antennas)*
> *- The building is not listed*".

23. On page 6 of the Officers Delegated Report, it states:

> "*Highways - All works are on an existing rooftop with no obvious line of sight, for oncoming traffic and it is not considered that the proposal would have any impact upon highway users*".

24. It is clear that neither of these points relate to the appeal scheme and should not have made up any element of the Local Authority's decision-making process. The inclusion of such information leads the Appellant to question whether or not the appeal scheme has been accurately assessed and due diligence undertaken by the Local Authority in forming it's decision to refuse planning consent for the appeal scheme.

25. In regard to the 'Consultations & Notification Responses' section of the Officers Delegated Report, the Appellant wishes to address three points highlighted within the Local Authority's document.

26. Firstly, one letter of objection was submitted by a local resident. The issues raised within this objection are captured within the Officers Delegated Report, stating:

> *"They are the owners of the property opposite this proposed 15 meter high monopole, which will be right in front of their view from every window in their home. It will also be the view from their garden. This will decrease the value of their home and living conditions".*

27. As outlined in paragraphs 8, 9, and 10, the location of the appeal site was strategically positioned to ensure that it would not sit directly opposite any residential property and would only be visible from the north-facing windows of the property, not **every** window in their home, as suggested above. It is submitted that views from the north-facing windows, whilst impacted, would be framed against mature tree cover which is situated both on the adjacent green area, but also within the gardens of residential properties opposite (on Slade Lane).

28. Furthermore, It is well understood by Town Planners that there is no entitlement to a view across a third party's land. As with views over any adjoining land, that the proposed radio base station may be visible from a nearby residential property does not necessarily equate to causing 'harm' and cannot normally be regarded as a material planning consideration. It is only when the visual impact of adjoining development, in this case the proposed radio base station, from a principal living room of a nearby property becomes **overbearing**, can it be considered as a material consideration. There is no reference within the Officers Delegated Report, or the Local Authority's Decision Notice, that the appeal scheme may be overbearing. No overshadowing, loss of daylight and sunlight will be caused to the property opposite, as a consequence of the appeal scheme.

29. This position was confirmed, in May 2016, when the Planning Inspectorate overturned a decision by the Council of the London Borough of Enfield for the installation of a 20m shared radio base station and 4no ground based equipment cabinets (CTIL and Telefonica UK Limited vs the Council of the London Borough of Enfield, APP/Q5300/W/16/3142885). In allowing the appeal, the Inspector stated the following in their Decision Notice:

> *'The proposal **may be visible from windows of residential properties**. However, due to the separation distances achieved between it and the nearest dwellings and its relatively slim profile at higher level, it could not be said to constitute an overbearing structure that would be unduly harmful to outlook. **In terms of the proposal's effects on private views, these are matters that the Courts have held can rarely be instrumental in planning decisions, and as such I only attach very limited weight** to these considerations in arriving at my decision'* (emphasis added).

30. Despite this, the Officers Delegated Report offers a conflicting view, suggesting that the protection of "*pleasant views over an area of open grassland*" is enough to outweigh the numerous public benefits which would be brought forward by the scheme:

> "*Residential amenity - There are a significant number of residential properties, in close proximity to the site, and it is considered that they currently have pleasant views over an area of open grassland, that would be detrimental impacted by the proposed development. As such, it is considered that the proposed development would have a harmful impact upon their visual and residential amenity*".

31. The Appellant suggests that, as such scenarios have been committed into case law via appeals such as that referred to in paragraph 29, above, then a significant level of planning weight should be given to these appeals where similar circumstances are evident.

32. In terms of the proposed structure, the monopole would be galvanised in order to assimilate the structure with the surrounding vertical utilitarian elements, and the antennas coloured grey. This will reduce the capacity of the antennas to draw the eye when viewed against the sky and compared to other street furniture which is in situ nearby. The width of the monopole is reduced to the smallest practicable, and, with the antennas 'stacked' within the structure, the need for a shrouded headframe is avoided.

33. As outlined in paragraph 26, the Officers Delegated Report states that the appeal scheme will "*decrease the value of their home*". The legislation is very clear in terms of what can be considered when a Local Authority assesses a GPDO Prior Approval application – with the focus on '*siting*' and '*appearance*'. The devaluation of residential property, or any property for that matter, is not a material planning consideration and should not have formed part of the Local Authority's decision-making process. That this was included, but not quantified, within the Officers Delegated Report would suggest that this formed part of the Case Officer's assessment of the appeal scheme. The Appellants submit that this should have formed no part of the Local Authority's assessment, nor should any of the points raised within paragraphs 27 – 31, and would not expect to see such a comment captured within this official documentation published by the Local Authority.

34. Secondly, the Officers Delegated Report states that a petition, signed by 54 local residents, was received by the Local Authority. This petition was not provided to the Agent to clarify any points raised during the life-span of the appeal submission, nor was it available on the Local Authority's Planning Portal to view. It remains unavailable at the point of submission of this appeal.

35. The Officers Delegated Report states that the Ferguson Court Residents Association, who submitted the petition, considered that "*the proposed development would have a detrimental impact on their lives, on the grounds of safety, appearance and TV interference*". Again, as with the single letter of objection, it is unclear from the Officers Delegated Report as to how much weight was given to this petition in assessing the scheme and the Local Authority arriving at their decision to refuse planning consent. No opportunity for the Agent to address the concerns raised within the petition was forthcoming from the Local Authority, and indeed, the first knowledge of this petition was its inclusion within the Officers Delegated Report. This is unfortunate, as, if given the opportunity, the Agent could have either clarified, or attempted to address, all of the points included within the petition.

36. In terms of TV interference, the Appellant's mobile network is hosted on a different frequency to that used by digital television. This point could have been easily addressed during the life-span of the original submission.

37. The other points raised – "*a detrimental impact on their lives, on the grounds of safety, appearance*" – are entirely subjective. Without ascertaining the exact nature of these points, they are difficult to address within this appeal; i.e. exactly how would the appeal scheme lead to a detrimental impact on their lives?; what was the nature of the objection in relation to safety, did this relate to Highways safety and/or visibility splays?; and what impact would the appearance of the appeal scheme have?

38. It remains unknown as to how much planning weight was given to each of these points, or if the Local Authority attempted to clarify each of the points made by the Ferguson Court Residents Association. The inclusion of such points in an Officers Delegated Report, without the usual caveat that some, or all, of these points are not acknowledged as material planning considerations, suggests that they are least formed some part of the Case Officer's decision. They were certainly deemed worthy of inclusion in the Officers Delegated Report, without further explanation as to how they fit into the Case Officers assessment of the appeal scheme. The Appellants submit that, as with the local resident objection, planning weight should only be given to the two material planning considerations in assessing GPDO Prior Approval application – i.e. 'siting' and 'appearance' – and that the Local Authority's assessment should have undertaken a balanced assessment of benefits vs harm, as advocated within the NPPF.

39. Lastly, in terms of the 'Consultations & Notification Reponses' in the Officers Delegated Report, it states that Highways Services offered the following comments:

> *"Both the mast and associated antennas and cabinets appear to be placed at the back of the adopted footway. However, it is unclear how large the equipment is and how much footway will be used. Highways would be accepting in-principle of these proposals subject to the final positioning of apparatus being sufficient to maintain the minimum desirable clearance of 2m to any adjacent street furniture and the edge of carriageway.*
>
> ***It is accepted by highways that the proposals would not cause a distraction to passing vehicles and would not give rise to forward visibility issues"*** (emphasis added).

40. As part of the original application, a scale drawing (1:100) was provided showing the Proposed Site Plan (drawing number 215 within the supporting drawing pack). Cabinet dimensions were also provided on page 5 of the Supplementary Information Document which accompanied the original planning submission. Using a scale ruler, or alternative desktop tools, it is evident that the remaining footway width, with the appeal scheme in situ, would measure in excess of 2m. For the avoidance of doubt, it can be confirmed that the remaining footway width would measure 2150mm, once the proposed apparatus is deployed. This clearly exceeds the measurements which the Highways Services consider as '*acceptable*'.

41. As the Highways Services confirmed that the proposals would **not** cause a distraction to passing vehicles and would **not** give rise to forward visibility issues, the grounds of safety, as cited by the Ferguson Court Residents Association (paragraph 35, above) have been addressed. It is hoped that the Highways Services comments were taken into consideration when the Local Authority assessed the Residents Association petition. The Appellant, however, is unaware of this as there was no clarification as to how this information was assessed, and the planning weight it was given, detailed within the Officers Delegated Report.

42. In all three instances referred to within the 'Consultations & Notification Responses', the Appellant would expect to see some level of clarity as to what was given planning consideration in the decision-making process, and, equally as important, what was not. There is no evidence of this,

and, as such, the Appellants submit that the assessment undertaken by the Local Authority has not been appropriate, and has not focused on the benefits of the scheme vs the harm, in regard to only 'siting' and 'appearance', but that a decision was formed which did not relate solely to 'siting and appearance'.

43. The appeal site is considered to be appropriate from both a 'siting' and an 'appearance' perspective. As outlined in the preceding sections of this document, the location of the appeal site was specifically selected to ensure that it sits out of direct view of nearby residential properties, as far as practicable, and outside of highways visibility splays, but also within the target area that it is designed to serve. It is submitted that the appeal site, whilst providing the necessary operational coverage to the target area, will not unduly impact on residential properties within the local area to a significant degree, and certainly not enough to warrant the refusal of planning consent from the Local Authority. This was the main intention of the Appellant at the time of site selection, and, as outlined within the appeal submission. It is submitted that no better, or less harmful, location could be identified within the target area, and that the appeal site offers the best, and wholly acceptable, town planning and environmental solution at which to deploy a brand-new ground-based installation.

44. The presence of the retail units on Slade Lane, to the north east of the appeal site, offer the only non-residential context to the local area. In selecting a site in close proximity to these retail units, it is submitted that the only utilitarian context within the wider area has been used to good effect, and will ultimately assist the presence of the appeal scheme on the opposite street corner.

45. As outlined within the appeal submission, the proposed monopole, and ground-based equipment cabinets, were proposed in a galvanised steel colour. Whilst the proposed apparatus can be coloured to reflect its location – i.e. generally green, black, brown, or grey – this standard, factory-default colour, was specifically selected to ensure that it matched with the colour of the existing street furniture within the local area; specifically the existing street lighting columns on Slade Lane, Burnage Lane, Cringle Hall Road, Milwain Road, and the surrounding road network, as well as the nearby bus shelter and road traffic signage.

46. As outlined, at length, within this document, the presence of mature trees immediately adjacent to the appeal site, measuring 7.5m and 10m, respectively, will provide a visual screen to the proposed monopole. The use of this natural tree cover therefore assists in filtering public and residential views of the appeal scheme, acting as both screening and backdrop, depending on the direction of view. This, combined with the intermittent, and mature, tree cover which lines Slade Lane and Burnage Lane, as well as mature trees within private gardens nearby, will assist in filtering short-, medium- and long-range views of the appeal scheme.

47. As will be discussed in greater detail within this document, the principle of the proposed development is enshrined within Part 16 of the Order. As per the relaxed Permitted Development regulations, which came into force in April 2022, the deployment of 20m monopoles is now recognised as being 'normal' and consider it to be akin to an outline planning permission. Despite the possibility of the Appellant deploying a 20m monopole under an application for Prior Approval, the Appellant was mindful of the perceived visual impact on the surrounding area, and the 'appearance' of the scheme, and duly submitted an application for the appeal scheme, with a top

height of 15m – somewhat 5m shorter than is established within the Order and routinely rolled-out nationwide.

48. The specific location of the apparatus on the highway was selected to ensure that no impact on either pedestrians, or vehicles, would result as a consequence of the appeal scheme. It should be noted at this juncture that, as outlined in paragraph 39, the Highways Service stated that they would be accepting, in-principle, of the scheme, should the final positioned of the apparatus result in a clearance of 2m between the apparatus and the edge of the carriageway, as well as confirming that the proposals would not cause a distraction to passing vehicles and would not give rise to forward visibility issues. As confirmed in paragraph 40, the remaining footway width will measure 2150mm. It is submitted that the confirmation of the acceptability of the appeal scheme, from a highways perspective, is borne out of the careful 'siting' of the apparatus within the local streetscene.

49. The Local Authority's Decision Notice states, in paragraph 2, above, that the City Council is not satisfied that the development was sited and designed to minimise the impact upon visual amenity and that the installation's height, siting and appearance would be unduly harmful to the surrounding area. In this document, the Appellants have laid out exactly how the visual impact was minimised: through clever site selection and ensuring that the apparatus is off-set to one side of the nearest residential property; the proposed galvanised nature of the apparatus, to mirror existing street furniture which is currently in situ; the utilisation of the existing mature trees; the proximity to the only non-residential buildings within the local area; the exact siting on the pedestrian footway leading to no Highways objection; a reduction in height of the monopole when compared to what is now considered to be 'normal' across the UK. Each of these points individually provide a more positive town planning and environmental option, and, when combined together, ensure that they result in a wholly suitable solution for the local area.

50. The appeal scheme will provide significant public benefits, with brand-new 3G, 4G and 5G network services provided to the area. These benefits will take the form of social, economic and environmental benefits. However, the only reference to the provision of a high-quality telecommunications network within the Local Authority's jurisdiction cited within Officers Delegated Report is a complete copy and paste of selected paragraphs from the NPPF. There is no explanation as to how the Local Authority attributed such national guidance and direction to the appeal scheme, nor the fact that any of the NPPF information and quotes reiterated within the Officers Delegated Report were applied within the decision-making process, save for a single line which reads:

"*The Council is mindful of the benefits that such developments bring*".

51. Th provision of brand-new network services for the Appellant in the local area is a very important factor which appears to have been overlooked by the Local Authority in determining this application, and, in fact, has been reduced to a single-line within the Officers Delegated Report. It is certainly clear from the Local Authority's documents that no planning weight was given to the provision of improved network services, capacity, coverage or connectivity, when assessing the appeal scheme, and that, ultimately, these benefits did not form part of the Local Authority's decision-making process.

52. As only the perceived negative impacts of the appeal scheme are highlighted within the Officers Delegated Report, it is clear that no balanced assessment, as advocated within the NPPF, which the Officers Report references at length, was undertaken in the process of reaching a decision and the Local Authority refusing its planning consent.

53. It is now becoming more and more apparent that a significant proportion of the national workforce are adopting a more hybrid-style of working – with many returning to an office environment for only a small proportion of the regular working week, whilst working from home for a large percentage of each week. As such, the necessary infrastructure must be deployed in order to assist and facilitate this hybrid working, as it predominantly occurs within a residential setting. As the appeal scheme will provide new 3G, 4G and 5G services to the local area, this is considered to be a major contributing factor to enabling such hybrid-working to take place within the Local Authority's jurisdiction. This, however, was not referred to within the Officers Delegated Report, or the Local Authority's Decision Notice.

54. The importance of permanent, and enhanced, telecommunications network coverage cannot be underestimated, especially throughout the years 2020 and 2021, when the dependence on these networks was higher than it has ever been. This dependence has continued into 2022 as our online shopping, gaming, and social habits have changed, post-pandemic, as well as the aforementioned working-from-home or hybrid work pattern which many employees are now choosing to adopt – searching for a more balanced lifestyle and leaving the days of the long work commute 5-days-a-week behind. In order to achieve this, and satisfy the demand that is clear within local communities across the UK, then the necessary apparatus needs to be deployed – and deployed in the most suitable locations. The Appellant's submit that the appeal site offers the most suitable location for the proposed scheme, within the target area.

55. The NPPF encourages a balanced assessment of any significant harm that may be caused by a proposed development, against the public benefits that the same development would bring forward. It is submitted by the Appellants that, even under 'pre-pandemic' circumstances, significant weight was not afforded to the public benefits of the appeal scheme, by the Local Authority, in refusing the appeal submission. In fact, no mention at all of these benefits was evident within the Local Authority's assessment of the appeal scheme. However, times have changed 'post-pandemic', with an ever-increasing reliance on mobile data consumption in all aspects of public life – from shopping, to gaming, to streaming-services direct to handset, and to socialising with friends and family. These habits were borne out of, and exacerbated by, the national lockdowns of 2020 and 2021, and are habits that show no sign of disappearing. No acknowledgment or reference was made to increased demand for network connectivity, capacity and coverage, from a public perspective, within the Local Authority's Decision Notice or Officers Delegated Report. This is a clear indication that this element of everyday public life formed no part of the Local Authority's assessment, or decision-making process.

56. Furthermore specific steps were taken to ensure that the visual impact was reduced as far as practicable. These steps will be discussed in further detail in the following paragraphs. It is also submitted that no further amendments or concessions could be implemented to further reduce the size, scale, height, or visual impact of the appeal scheme.

3.1 The Need for Development And Associated Public Benefit

57. H3G (known as the operator 3, or Three UK) is licenced to operate Third, Fourth and Fifth Generation electronic communications services.

58. As detailed within the planning application, the appeal proposal seeks to deploy a new base station at the appeal site, which will provide brand-new 3G, 4G and 5G coverage to the local area. The scheme was designed to ensure it is the smallest and thinnest available, utilising an innovative solution will allow the antennas to be 'stacked' within the structure itself.

59. 3G (UMTS) allows for data transmission as well as text services as mobile phones, computers, and other portable electronic devices access the internet wirelessly. 4G (LTE, the acronym used for 'Long Term Evolution') supports mixed data, voice, video and messaging traffic and offers speeds of up to five times faster than 3G, enabling network users with 4G devices to benefit from ultra-fast internet browsing, video streaming, gaming, e-mail and downloads.

60. 5G is the next generation of mobile internet connectivity, offering faster speeds and more reliable connections on smartphones and other devices than ever before. Compared to even the most recent and efficient generation of mobile network, 4G, 5G is set to be far faster and more reliable, with even greater capacity and lower response times.

61. 5G is now routinely rolled-out across the UK, with existing 3G and 4G installations being upgraded to provide 5G coverage, capacity, and connectivity. In order to assist this roll-out of 5G, brand-new base stations will be required to fit into the network and complete a blanket of Operator coverage across the UK. This is not only the case for the Appellant's network, but for the networks of all Mobile Network Operators.

62. The benefits of high class digital connectivity services were outlined to the Local Authority within the planning application, where it was detailed that high quality communications infrastructure is essential for sustainable economic growth and that high speed broadband technology and other communications networks can also play a vital role in enhancing the provision of local community facilities and services. Mobile connectivity allows business to be done on the move, enables access to information and services anywhere, and opens up new opportunities and markets.

63. The Government unambiguously recognises the vital importance of the development of essential modern electronic communications services for residents and local economies, and has done so even prior to the rollout of 5G. As such, the urgent delivery of the required network services continues to be a Government priority. This was evident in April 2022, when changed were made to Part 16 of Schedule 2 to the Town and Country Planning (General permitted Development) (England) Order 2022 (as amended), relaxing Permitted Development Rights to allow for a smoother roll-out of 5G services for all Mobile Network Operators.

64. Within his presentation to Parliament in July 2015 of the Government report "Fixing the Foundations: Creating a more prosperous nation"[1] the Chancellor of the Exchequer reiterated the importance of a high speed digital communication infrastructure:

> *"7.1. Reliable and high quality fixed and mobile broadband connections support growth in productivity, efficiency and labour force participation across the whole economy. They enable new and more efficient business processes, access to new markets and support flexible working and working from home.*
>
> *By reducing regulatory red tape and barriers to investment, the government will support the market to deliver the internationally competitive fixed and mobile digital communications infrastructure the UK's businesses need to thrive and grow, and which will enable the UK to remain at the forefront of the digital economy. The government is working with business so that the market can play the lead role in delivering against the ambitions set out in the Digital Communications Infrastructure Strategy, published in March, of near-universal 4G and ultrafast broadband coverage."*

65. This position was reinforced by a statement made by then incumbent Prime Minister David Cameron in March 2016 when he specifically addressed the vital importance of mobile connectivity for residents and local economies and highlighted that the urgent delivery of the required network improvements is a Government priority;

> *"Ten years ago, we were all rather guilty of leading campaigns against masts and all the rest of it. Our constituents now want internet and mobile phone coverage. We need to make sure that we change the law in all the ways necessary, that the wayleaves are granted, that the masts are built, that we increase coverage and that everyone is connected to the information superhighway."*

66. The 2016 report, "Connected Future"[2], published by the National Infrastructure Commission addressed the steps necessary to put the UK at the forefront of emerging digital communications technology which it described as "*critical to the growth of our economy*" and made recommendations to the Government on how to achieve them. The commission reported, on page 2, that:

> *"The Commission's central finding is that mobile connectivity has become a necessity. The market has driven great advances since the advent of the mobile phone but government must now play an active role to ensure that basic services are available wherever we live, work and travel, and our roads, railways and city centres must be made 5G ready as quickly as possible…Greater connectivity is inevitable and essential. The UK cannot be left behind".*

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[1] Fixing The Foundations: https://www.gov.uk/government/publications/fixing-the-foundations-creating-a-more-prosperous-nation

[2] "Connected Future" report (2016) https://nic.org.uk/studies-reports/connected-future/

67. This was further substantiated in the written statement by the Minister of State for Housing and Planning, Brandon Lewis, (HCWS631) titled '*Boosting Mobile Connectivity*'[3] on 17th March 2016, which commits to provisions for *"greater freedoms and flexibilities for the deployment of mobile infrastructure"*. The proposed electronic communications base station forms a part of this greater drive to address the deficit in these essential electronic communications services.

68. The London Assembly's Regeneration Committee described digital connectivity within its "Digital Connectivity in London" report[4], published June 2017, as the *"'fourth utility', an everyday necessity alongside water, gas and electricity"* and also noted that "*mobile broadband is, and will continue to be, an essential complement of fixed broadband*". This is the case across the UK and not limited to the capital.

69. At the time of writing, the Covid-19 Coronavirus pandemic appears to be firmly behind the UK as a country. There are no longer social restrictions within our communities and we are once again free to choose where and when to socialise and work. However, the lasting impacts of the Coronavirus pandemic remain, with the population of the country living through three national lockdowns, and peoples social and work behaviours being altered drastically, and in most instances, permanently. The result of the Coronavirus pandemic resulted in a massive shift from office based to home working, from physical, professional and social gatherings to virtual ones and to unprecedented reliance on online shopping and entertainment services.

70. Data usage and network reliance within suburbs increased dramatically as less people travelled to town and city centres to shop, work and socialise. The result of this was a shift in demand on the networks – from areas of high network capacity, coverage and connectivity (i.e. city centre offices and business parks) to areas of far lower network service (i.e. suburban and residential areas). This demand within these suburban and residential areas shows no sign of diminishing, with a significant proportion of the UK employment market offering options to work-from-home in some capacity. Workers are now actively seeking out alternative jobs and roles which will allow them to work from home, rather than return to the office space. The demand for these network services is clearly there, and the Appellant, in this instance, has tried to meet that need within Burnage.

71. It is anticipated that the current shift towards homeworking and online services will persist, albeit to a lesser degree, in the future, although this does remain unknown. It is therefore vital that the infrastructure is in place throughout the UK to meet this demand.

72. Even prior to the sharp rise in mobile dependency in 2020, the importance of connectivity was already well recognised. This is evidenced within Ofcom's annual connectivity report. The 2018 report[5] provided a figure of 92 million active mobile subscribers in the UK at the end of 2017. It

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[3] "Boosting Mobile Connectivity" statement (20160) https://questions-statements.parliament.uk/written-statements/detail/2016-03-17/HCWS631

[4] "Digital Connectivity in London" (2017) https://www.london.gov.uk/sites/default/files/digital_connectivity_report_final.pdf

[5] Ofcom 2018 connectivity report - https://www.ofcom.org.uk/research-and-data/multi-sector-research/cmr/cmr-2018/interactive

detailed that 78% of adults used a smartphone and that 76% of mobile users were using their devices for web and data access.

73. Further, the report noted that *"Falling call volumes are symptomatic of a fundamental change in people's behaviour; web-based forms of communication are now the primary way in which many consumers use their mobile phones".* Following on from this, the report stated also that *"Growing numbers of smartphone users, faster mobile networks, the launch of new bandwidth-hungry services such as video streaming, and larger pay-monthly data allowances have all contributed to rapid growth in subscribers' average mobile data use".*

74. The report detailed that users are spending an increasing amount of time per day using their mobile phone. 68% of participants in the Touchpoints research reported that they "*could not live without*" their mobile phone (rising to 78% among 25-34s). Whilst not included within the research figures, anecdotal evidence suggests that this number is greater still amongst those aged under 18. All of which points towards the nations increasing dependency on mobile services and connectivity.

75. The summary of key findings from the 2019 Communications report[6] documented that the average fixed and mobile data consumption then increased rapidly in 2018, with average data use per fixed broadband line increasing by 26% to 240GB per month, and average monthly use per mobile data connection increasing by 25% to 2.9GB. At the same time, fixed line usage declined dramatically, with outgoing calls dropping by 17% and the number of landlines in use dropping by 0.2 million to 32 million, revealing a definite and dramatic shift towards reliance on mobile communications and connectivity services.

76. Thus, it is clear that data-based technologies such as 4G are increasingly important to our everyday lives, even during usual circumstances, and 5G will arguably only intensify this.

77. The Ofcom Connected Nations 2020 UK Report[7] outlines a sharp increase in both mobile and voice data, particularly during the enforced national lockdowns of 2020. The report states that average call volumes and average call duration increased in the week that national lockdown was introduced in March 2020, with mobile hotspots shifting away from city centres to the suburbs and residential areas as restrictions continued.

78. Significantly, the same report states that the consumption of mobile data saw a staggering rise of 42%, when compared with the previous year. Additionally, the traffic carried in England in June 2020 (during lockdown) exceeded that carried across the whole of the UK (England, Scotland, Wales, and Northern Ireland) in February 2020 (prior to lockdown).

79. In his speech at Connected Britain 2020[8], in September 2020, Digital Infrastructure Minister, Matt Warman, stated the following:

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[6] Ofcom 2019 connectivity report – summary of key findings
https://www.ofcom.org.uk/__data/assets/pdf_file/0028/155278/communications-market-report-2019.pdf

[7] Ofcom Connected Nations 2020 UK Report (2020)
https://www.ofcom.org.uk/__data/assets/pdf_file/0024/209373/connected-nations-2020.pdf

[8] Matt Warman's Keynote Speech at Connected Britain 2020
https://www.gov.uk/government/speeches/matt-warmans-keynote-speech-at-connected-britain-2020

"COVID has altered the way we live, work and, most importantly, stay connected with our family and friends. The digital infrastructure that keeps us all connected was essential to our daily way of life under lockdown - and is now more important than ever as we head into recovery. Many of these changes - such as increased working from home - will stay with us for the foreseeable future".

80. The implementation of a third national lockdown in January 2021 saw a return to most aspects of life associated with the two previous lockdowns, and the same increases in voice calls and mobile data consumption were expected. Mr Warman also stated the following:

"The world is in the middle of a digital revolution. COVID has accelerated this process, digitising almost every part of our everyday lives and making the infrastructure that connects us more important than ever. That's why it is at the top of the government's agenda".

81. Central Governments' direction of travel is to support the roll-out of 5G technology and this has been facilitated by the relaxation of Permitted Development Rights. Since its initial roll-out in 2019, the Operators have continued to deploy 5G across the UK at pace. As outlined in the Ofcom Connected Nations Report[9], the number of mobile base stations providing 5G services has more than doubled in the last 12 months, to over 6,500 sites across the UK.

82. The latest Ofcom Connected Nations Report[10] shows that 47-62% of UK premises are covered by 5G from one Operator, whilst between 4-12% of the same UK premises are covered by all Operators. It is expected that both percentages will continue to grow as existing base stations are upgraded to enable the provision of 5G services, as well as the deployment of brand-new base stations in locations which currently received no signal from a particular Operator. The Report also goes on to state that mobile networks continued to perform well despite significant demands as people and businesses relied on their mobile phones during sustained periods of lockdown during the Covid-19 global pandemic.

83. Given the historical trend of increasing mobile phone usage and dependency, as outlined in Ofcom's 2018 and 2019 Connectivity Reports, as well as the significant changes in user behaviour and increases in data consumption outlined in Ofcom's Connected Nations 2020 UK Report, it is clear that the country's reliance on these networks is at an unprecedented level and may never return to pre-pandemic levels. This is further reinforced by the figures provided within the Connected Nations 2021 and 2022 UK Reports.

84. West Midlands 5G (WM5G) is an organisation set up to accelerate the benefits of 5G throughout the region. WM5G is wholly owned by the West Midlands Combined Authority and works in partnership with public and private sector organisations. The following are examples of case studies which demonstrate how 5G technology can be applied to provide public benefits. The

[9] Ofcom Connected Nations Report 2021
Connected Nations 2021: UK report (ofcom.org.uk)
[10] Ofcom Connected Nations Report 2022
Connected Nations update: Spring 2022 (ofcom.org.uk)

benefits will apply to anywhere in the country where 5G services are available and so the case studies are relevant to the appeal proposal, despite the appeal site falling within a different geographical region.

> *'The outbreak of COVID-19 has cast a spotlight on mobile and broadband technology, the enabler for so many of the services we now rely on.* ***Keeping connected helps our healthcare services and other key workers respond to the COVID-19 pandemic, it helps those in lockdown at home interact*** *with their loved ones via Zoom and other conferencing services, and it is also helping* ***tens of millions of employees to work remotely.****'*
>
> *'No matter how we end up emerging from this global crisis, the* ***trend of an increased demand for digital connectivity will only continue****. For example, now that the possibility has been proven, millions more workers will continue to rely on remote working in order to increase productivity and improve their respective work-life balances.' (emphasis added)*
>
> *'Recovering after coronavirus will require disseminating vital information, connecting crucial services, leveraging big data and artificial intelligence (AI) as well as adopting new ways of working – and this all needs to be supported by ensuring stable network connectivity.'*[1]

85. With regards to the impact of 5G services on Education WM5G has reported that:

> *'From an academic perspective,* ***the ubiquity of high-speed broadband and mobile connectivity, combined with new virtual learning platforms, creates the opportunity to deliver education to anyone, anywhere in the world.*** *The ways in which we can all access and benefit from education are changing. Many are choosing to study online now… Equally, learning on the job is now possible too, thanks to technologies such as Augmented Reality (AR) goggles, which can* ***give engineers real-time instructions on how to fix a machine on a production line****, for example.'*[2] *(emphasis added)*

86. With regards to the impact of 5G services on Manufacturing, WM5G has reported that:

> *'5G's increased capacity (ability to support thousands of devices on a factory floor at once), low-latency (ability to connect high volumes of devices in real-time) and enhanced security (through private networks which securely store data locally and can be managed on-site rather than in the cloud) make it ideal to support manufacturers to* ***transform productivity****. This opens up* ***endless possibilities for advancements*** *such as predictive maintenance, virtual reality and augmented reality.'*[3] *(emphasis added)*

87. With regards to the impact of 5G services on Healthcare provision WM5G has reported that:

> *'**5G will prove critical in providing the infrastructure required to deliver remote health services over the next decade**. By design, 5G's ability to deliver real-time information (low latency), ultra-fast speeds (critical for high definition images and video), increased capacity and heightened security are going to be fundamental in scaling the patient benefits of remote healthcare and keeping medical records secure and private'*
>
> *'trial demonstrated how a **paramedic was able to perform a remote-controlled ultrasound scan on a patient in an ambulance over a public 5G network**. Real-time high definition imagery was fed back to a physician over a 5G video link – something that 4G is not fast enough to support. The doctor in the hospital was able to control the ultrasound scan through a special haptic glove. This meant that the doctor could make a more accurate diagnosis on behalf of the paramedic, allowing the patient to be transferred to the most appropriate hospital to receive the right care*[4] *(emphasis added)*

88. The Planning Inspectorate has also shown recognition of the vital importance of mobile connectivity. Evidence of this is provided by the following three appeals which were overturned by the Inspectorate and have been included as Appendices in this appeal.

89. In May 2016, the decision of The Council of the London Borough of Hillingdon to refuse planning permission for the installation of a 15m high streetworks pole supporting 6no antennas, 2no ground based equipment cabinets and development ancillary thereto was overturned by the Planning Inspectorate (CTIL and Telefonica UK Ltd Vs the Council of the London Borough of Hillingdon, appeal reference APP/R5510/W/16/3143922).

90. The scheme proposed the deployment of a 15m streetpole within 20m of an existing 15m streetpole, on highways land, within a Conservation Area. The Local Authority refused the application as they considered that the "*proposed development would result in an incongruous and visually obtrusive form of development*".

91. Despite this, the Inspector's Decision Notice stated:

> *"The Framework sets out the importance of an advanced high quality communications infrastructure for sustainable growth and makes specific reference to the development of high speed broadband technology. This is reflected in the London Plan and the public benefit arising from the improvement of the telecommunications infrastructure is a material planning consideration that weighs in favour of the proposal.*
>
> *Taking account of all matters I have concluded that the limited harm caused to the significance of the heritage asset (the CA) would be outweighed by the public benefit that would arise from improving the communications infrastructure".*

92. In November 2018, the decision of Mendip District Council to refuse its Prior Approval for the installation of a 15m electronic communications mast and associated cabinet was overturned by

the Planning Inspectorate (Vodafone Ltd vs Mendip District Council, APP/Q3305/W/18/3206555). Within their Decision Notice, the Inspector stated:

> *"In considering the need for the proposal, Government policy, as set out in the Framework states that advanced, high quality and reliable communications infrastructure is essential for economic growth and social well-being. In this respect, I have found that there is a need for the proposal which therefore weighs strongly in its favour. As I have found that the level of harm relating to this second main issue* (i.e. the impact on the character or appearance of the Conservation Area and setting of the Listed Buildings – our comment) *would be low, that identified need would outweigh the harm in this case*".

93. In October 2020, the decision of Elmbridge Borough Council to refuse planning permission for the installation of a 15-metre-high monopole incorporating shrouded antenna and supporting 2no external dishes was overturned by the Planning Inspectorate (EE Ltd and H3G UK Ltd Vs Elmbridge Borough Council, appeal reference APP/K3605/W/19/3243927). Within the decision notice, the Inspector stated that:

> *"The mast would be taller and thicker than the existing nearby street lighting columns, road signs and overhead cable poles. Due to its height, the mast would be visible in local views from the public domain and from some residential properties in proximity….However,* ***such masts are becoming more commonplace within the urban environment and so it would not appear as an alien or unexpected feature****"* (our emphasis).

94. The above three appeals all relate to the installation of ground-based telecommunications apparatus; some of which were situated within Conservation Areas, and in close proximity to Listed Buildings. Despite the Inspector, in each instance, recognising the harm which these developments would cause to nearby heritage assets, all three appeals were allowed, with the Inspector on each occasion stating that the public benefit of each proposal outweighed the limited harm. The Appellants submit that no-such balanced assessment of the appeal scheme was undertaken by the Local Authority, and, as such, the benefits of the scheme were not recognised nor included in the decision-making process.

95. Whilst the above three appeals all relate to the installation of 15m-high monopoles, there are other examples of taller installations being allowed by the Inspectorate where it has been considered that the benefits of each scheme were not taken into consideration.

96. In October 2018, the decision of Winchester City Council to refuse its Prior Approval for the installation of a 17.5m high pole, supporting 3no antennas and associated ground-based equipment cabinets was overturned by the Planning Inspectorate (CTIL and Vodafone Ltd vs Winchester City Council, APP/L1764/W/18/3197522). Within their Decision Notice, the Inspector stated:

> *"There are several vertical structures along this part of the road including streetlamps, telegraph poles, street signs and traffic lights, but at 17.5m, the pole*

would be considerably higher than any of these. Its additional width compared with other structures would also result in the pole appearing as a conspicuous feature. Whilst from some viewpoints a backdrop of trees would soften the appearance of the pole, from other locations along Andover Road, it would appear as a prominent feature. Its siting on the kerb build out close to the road carriageway would add to this prominence when viewed from positions closer to the site. Although such poles and associated cabinets are becoming more commonplace, the height of the proposed pole and its prominent siting would not assist its assimilation into the street scene when viewed from close quarters. There would therefore be some harm to the character and appearance of the area".

97. Despite this, the Inspector concluded that

> *"the proposal's public benefit in maintaining and enhancing local telecommunication coverage and capacity would outweigh the limited harm arising to the character and appearance of the area"*

98. In March 2021, the decision of Broadland District Council to refuse its Prior Approval for the installation of a 17.5m high pole, supporting 6no antennas and a wraparound cabinet at its base; and 6no ground-based equipment cabinets was overturned by the Planning Inspectorate (Mobile Broadband Network Limited vs Broadland District Council, APP/K2610/W/21/3280694). Within the decision notice, the Inspector made specific reference to the '*Living conditions of the occupiers of neighbouring properties'*, stating that:

> "***At the location where the mast is proposed to be located there are houses which face onto, but are not accessed from, Dussindale Drive. These houses are set behind hedges and fences and separated from the proposed site of the mast by a cycleway and footpath. They also have front gardens and drives between the front elevation of the house and the cycleway and footpath.*** *The proposed equipment cabinets would not be visible from these houses. However,* ***the mast would be visible from the windows of their front elevations***" (emphasis added).
>
> "*Policy GC4 of the DPD seeks, amongst other things, to consider 'the impact upon the amenity of existing properties' of new development.* ***Whilst the proposed mast is significantly taller than other street fixtures in the area it has a slim profile and will be finished in a light grey colour****. It is also set off the boundary with existing residential properties with a cycleway and footpath in between the proposed site and the boundary of the houses. In these respects, it is therefore consistent with Policy CG4 of the DPD*" (emphasis added).
>
> "*Moreover,* ***the residential properties have front gardens and drives between their front elevations and their boundaries. Consequently, given the slim profile of the mast, its light grey colour, and its distance from the front elevations of nearby properties I do not consider that its siting and***

appearance would unacceptably harm the outlook of the occupiers of these properties" (emphasis added).

99. The above appeal is particularly relevant to this appeal, as it is a very similar to the situation in regard to the proximity of residential properties to the appeal site. As outlined in the Local Authority's Decision Notice, and in further detail in the Officers Delegated Report, the appeal scheme was considered to be "*unduly harmful to the character and visual amenity of the streetscene and nearby residential properties, as well as the adjacent green space off Cringle Hall Road*". The above appeal scheme was closer to the boundary of residential properties than proposed at the appeal site, with that scheme also being visible from front windows. However, despite the similarities in both appeals, there are also significant differences. As part of appeal APP/K2610/W/21/3280694, a 17.5m monopole was proposed, rather than a 15m as is proposed at the appeal site. The 17.5m monopole is a more robust structure than the proposed 15m monopole, and 6no. ground-based equipment cabinets were proposed, as opposed to 3no. ground-based equipment cabinets in this instance. In almost all elements of appeal APP/K2610/W/21/3280694, the scheme led to a greater visual impact on the surrounding area – it was taller, wider, more robust, accompanied by more ground-based cabinets, not framed within views of mature trees, closer to the boundary of residential properties, and visible from more residential properties and windows. Despite all of this, the Planning Inspectorate allowed the appeal.

100. The Appellants submit that the same principles should have been applied to the original application, and, if that were the case, it would have led the Local Authority to granting planning consent, rather than refusing it.

101. Whilst the two appeals outlined above relate to the installation of monopoles measuring 17.5m high, there are further examples of monopoles that are even taller, being considered acceptable by the Planning Inspectorate.

102. In November 2021, the decision of the London Borough of Hillingdon Council to refuse their Prior Approval for the installation of a 20-metre-high monopole and associated cabinets was overturned by the Planning Inspectorate (MBNL Limited Vs London Borough of Hillingdon Council, appeal reference APP/R5510/W/21/3269903). Within the decision notice, the Inspector stated that:

> *"Based on the evidence before me,* ***the height of the monopole would be substantially taller than the mature trees which bound the site. Accordingly, it would represent a significant departure from the established height of existing lampposts with the height of the proposed structure representing a visually dominant addition to the existing environment.*** *Due to the substantial height of the monopole, and plethora of associated cabinets, the proposal would detract from the pleasing greenery within which it would be located.* ***This would harm the established landscape feature which positively contributes to the surrounding area as well as causing some harm to the visual amenities of surrounding properties, particularly those within converted office premises****.* (emphasis added).

*"**The proposal would also be located relatively close to three Grade II Listed Buildings**. However, because the proposal does not seek planning permission or permission in principle, the duty established within Section 66 of the Planning (Listed Buildings and Conservation Areas) Act 1990, does not apply to this proposal. **Despite this, the Framework still requires the heritage implications to be fully considered**".* (emphasis added).

*"Accordingly, **although the siting and appearance of the proposed development would cause some limited harm to the setting of the nearby listed buildings, I am satisfied that the economic and social benefits of the proposal, would outweigh this harm**"* (emphasis added).

103. In June 2021, the decision of Ashford Borough Council to refuse their Prior Approval for the installation of a 20-metre-high monopole and associated cabinets was overturned by the Planning Inspectorate (Telefonica UK Limited Vs Ashford Borough Council, appeal reference APP/E2205/W/20/3261389). The Inspector included the following in their decision notice:

"*Part 16 of the Order establishes that **the proposal is permitted development** and therefore it is accepted in principle by virtue of the legislation. **Furthermore, there is no requirement to have regard to the development plan as there would be for any development requiring planning permission.** Nevertheless, Policies SP1, SP6 and ENV13 of the Ashford Borough Council Local Plan to 2030 are material considerations as they relate to issues of siting and appearance. In particular, they seek to secure high quality design and to avoid development that would cause loss or substantial harm to the significance of heritage assets. **Similarly, the National Planning Policy Framework is also a material consideration and this includes a section on supporting high quality communications***" (emphasis added).

104. In June 2021, the decision of Sheffield City Council to refuse their Prior Approval for the installation of a 20-metre-high monopole and associated cabinets was overturned by the Planning Inspectorate (MBNL Limited Vs Sheffield City Council, appeal reference APP/J4423/W/21/3268791). Within the decision notice, the Inspector stated that:

*"Paragraph 80 of the Framework advises that **significant weight should be attached to the economic benefits of providing and enhancing electronic communications infrastructure**. Paragraph 112 advises that advanced, high quality and reliable communications infrastructure is essential for economic growth and social well-being, and that the expansion of electronic communications networks, including next generation mobile technology, such as 5G, should be supported.*

The proposal would reinstate 2G, 3G and 4G coverage within the area as well as providing 5G coverage, services would collectively increase network capacity and provide ultra-fast and more reliable mobile connectivity, capable of handling ever increasing data requirements. The development would provide extensive social

and economic benefits to individuals, businesses, and public services, including education and healthcare. The Council does not question the social and economic benefits that would result from the proposal but concludes that they do not outweigh the harm found. However, as no suitable alternative sites have been identified, I attach substantial weight to the benefits that would result from the proposal.

In weighing all the above matters, although I have found that the siting and appearance of the proposal would significantly harm the character and appearance of the area, I consider the substantial social and economic benefits of the proposal outweigh the harm identified" (emphasis added).

105. The Appellants submit that the same conclusions can be drawn from the eight appeal schemes outlined above, and that the same environmental, economic and social benefits will be brought forward via high-quality and reliable communications infrastructure, which is encouraged by national and local planning policy, and the enhanced provision of local network services to the surrounding area. However, unlike the appeals outlined above, the appeal scheme will result **no** impact on heritage assets or planning designations and should be considered a wholly appropriate solution for the local area.

106. The Appellants encourage the Planning Inspectorate to make a clear distinction between 'visibility' and 'harm', and, submit that, despite the appeal scheme being visible, it is not harmful. Furthermore, it is certainly in no way harmful enough to justify the Local Authority's refusal, when it is compared to the significant public benefits that it will be bring forward.

107. As with the deployment of all telecommunications base stations, at every local authority across the UK, the height of the apparatus is solely dictated by its function and the surrounding area. In this instance, the appeal scheme has been reduced in height to the very lowest (15m) deployable, without impacting on the operational efficiency of the apparatus.

108. As outlined in the preceding paragraphs, the size, scale and robustness of the appeal scheme has been reduced as far as practicable. The apparatus is designed to perform **one** single function – to provide network connectivity, capacity and coverage to the local area, for Three UK. This single function dictates the height which is required for the apparatus to be operationally efficient and effective. If the apparatus was reduced in height, it would not be able to fulfil the sole function for which it is present.

109. Paragraphs 89 – 105 of this statement provide examples of situations where 15m-, 17.5m-, and 20m-high monopoles have all been allowed by the Planning Inspectorate, after it has been determined that due weight was not applied to each of those applications in terms of the provision of high-quality telecommunications services, which is actively encouraged within the NPPF.

110. Respectfully, the Appellants suggest that the same notion should be applied here, with no reference within the Officers Delegated Report to the benefits of the scheme, but that it rather focused on the visual impacts on the surrounding area, and this factor only.

111. A number of the appeal examples cited within this document involved locations which were either within designated area, next to designated areas, and/or in close proximity to heritage assets and Listed Buildings. Despite harm being identified in all of the appeal examples, the Planning Inspector, in each instance, stated that the social, economic and environmental benefits of the scheme outweighed the identified harm, even where heritage assets and planning designations were present. The Appellants submit that the same notion can be applied to the appeal scheme and that the scheme itself is wholly acceptable and in alignment with national planning policy, and therefore Prior Approval should have been granted at application stage.

Technical Constraints

112. The design of the appeal proposal, and thus the level of visual impact, is directly influenced by the technical constraints of deploying a new base station. As this base station will provide network coverage for Three UK, and multiple technologies (3G, 4G, and 5G) the height and width is dictated solely by operational functionality.

113. The Code of Practice for Wireless Network Development in England (2022) replaces the Code of Best Practice on Mobile Network Development in England (2016). The Code of Practice of was produced by a working group comprising, the Department for Culture Media and Sport, the Department of Levelling Up, Housing and Communities, the Department for Environment, Food and Rural Affairs, The Department for Transport, Historic England, Natural England, National Highways, Mobile UK, Cornerstone Telecommunications Infrastructure Limited, Mobile Broadband network Limited, Cellnex UK, Wireless Infrastructure Group, Local Government Association, National Parks England, National Association of Areas of Outstanding Natural Beauty, Ofcom, and the Planning Officers Society. The Appellants take guidance from it in the siting and design of all their new sites and upgrades.

114. The principal aim of the Code of Practice is to support the Government's objective of delivering high quality communications infrastructure whilst balancing these needs with environmental consideration. The Code of Practice recognises that "*digital connectivity is vital to enable people to stay connected and businesses to grow. Fast reliable digital connectivity can deliver economic, social and well-bring benefits for the whole of the UK*".

115. Paragraph 9 of the Code of Practice states:

> *"As the demand for mobile data in the United Kingdom is increasing rapidly, it is important that everyone has access to dependable and consistent mobile coverage where they live, work and travel".*

116. In relation to the provision of the 5G network, for all Operators, across the UK, the Code of Practice states:

> *"With the introduction of 5G, more equipment will be required to provide coverage and capacity. 5G, as well as 4G, are data-driven technologies, and high volumes of data will be transmitted between base stations and wireless devices. 5G will*

require a denser network of base stations than previous generations, including more fixed line fibre optic cable for reliable and high capacity backhaul. The siting of 5G installations will be more constrained and guided by these special technical and operational considerations"

117. It is submitted by the Appellant that the appeal scheme has been reduced as far as practicable, in accordance with the Code of Practice and the GPDO, to ensure that the minimum level of apparatus, at the minimum height, is deployed in this instance.

118. As technology has continued to advance, the technical constraints associated with the deployment of 5G compatible sites place even greater limitations on siting and design opportunities, leading to the creation of the Code of Practice (2022), in place of the previous Code of Best Practice on Mobile Network Development in England (2016), in which these constraints are detailed at length.

119. Of particular relevance to the appeal scheme is paragraph 39, which states:

> *"Mast positioning: all new masts should be sited, so far as is practicable, so as to minimise their impact on their setting, including the landscape and any buildings. This includes siting next to similar structures -* ***streetworks masts, for example, should ideally be sited in line, and in harmony, with existing vertical infrastructure, such as street lighting columns, to minimise their visual impact****.* ***Placing a mast within or adjacent to an existing group of trees, vegetation and other natural features can reduce visual impact***" (our emphasis).

120. In terms of the appeal site, it is wholly aligned with the guidance provided within the Code of Practice (2022). The proposed monopole has been specifically positioned to ensure that it sits as far away from the nearest residential property as practicable, without encroaching into any visibility splays at the Cringle Hall Road and Slade Lane junction. It should be reiterated at this juncture that the Highways Service confirmed that they were happy with the appeal scheme in terms of impacts on visibility splays and that no driver distraction would be caused as a consequence of the proposed apparatus.

121. Furthermore, the apparatus has been proposed to ensure that it remains in-line with existing streetlighting columns which illuminate the surrounding road network; all of which are positioned to the rear of the pedestrian footway. This is aligned with the above guidance. Furthermore, the proposed monopole has been positioned in close proximity to existing mature trees which bound the adjacent green space off Cringle Hall Road. This will ensure that perceived visual impact of the scheme is reduced via green screening, and public views of the installation are suitably filtered, to some degree.

122. A justification for the design specifically selected for the appeal site was also provided within the Supplementary Information document. It was confirmed that every element of the proposed design had been kept to the minimum, in terms of volume and scale of apparatus, permitted by operational requirements, and that there was no scope to alter the design from that which was proposed.

3.2: The Planning Policy Context Of The Refusal

123. As outlined in paragraph 2 of this document, the Local Authority cited one reason for refusal within their Decision Notice in which they considered the appeal scheme failed to comply. This reason for refusal related to the height, siting and appearance of the development and the impacts that will be caused because of this.

124. As outlined in this document, the Appellants do not concur with the Local Authority's decision, nor the suggestion that the appeal scheme would result in an unacceptable impact upon visual amenity. Paragraphs 25 – 56 of this document explain exactly how the visual impact of the scheme has been minimised. Whilst it is acknowledged by the Appellant that each application must be assessed on its own merits, paragraphs 89 – 105 provide examples of eight appeals that have been allowed by the Planning Inspectorate in recent years, overturning the decisions of Local Authorities in the process. All of these appeals relate to the proposed installations of monopoles which are either of equal height to the appeal scheme, or considerably taller (some being 33% taller and measuring 20m in height). In each of these appeals, a range of harm was identified – some to heritage assets and designated areas, some to residential and visual amenity. Despite this harm being identified, all appeals were allowed by the Planning Inspectorate.

125. Whilst each application needs to be assessed on its own merits, it must also be acknowledged that there are indeed a limited number of monopole 'designs' than can be assessed, with the installation of one monopole in a residential area being largely similar to the installation of another monopole in a different residential area, in principle. The same considerations must be made by Local Authorities in each instance – i.e. impacts on heritage assets; impacts on highway safety, pedestrian footway, visibility splays; impacts on the visual amenity of the surrounding area. Whilst these factors will vary within each application, the principle remains the same – i.e. is the installation of a 15m(+) monopole in this location acceptable? The Appellants would suggest that, given the number of appeals that have allowed by the Planning Inspectorate in recent times, that a 15m monopole in a residential area is wholly appropriate. This notion is supported by the relaxation of Permitted Development Rights in April 2022, with greater rights for the deployment of telecommunications apparatus granted by Central Government, to assist in the roll-out of 5G networks for **all** Mobile Network Operators.

126. The Local Authority state that planning consent was refused on the grounds that the appeal proposal would be harmful to the visual amenity of the area. The Appellant submits that this is not the case and that the Local Authority's determination of the appeal submission does not afford appropriate weight to the siting and design of the scheme, but also the numerous public benefits that would be brought forward by it, which the Appellants consider outweigh any perceived visual impact.

3.2.1 National Planning Framework

127. Paragraph 11 of the NPPF states that a presumption in favour of sustainable development lies at the heart of the planning system and, in respect of decision-taking, this means that development proposals that accord with the provisions of the Development Plan should be approved without delay.

128. Paragraph 7 of the NPPF states:

> "*The purpose of the planning system is to contribute to the achievement of sustainable development*", and in paragraph 10 that "*at the heart of the Framework is a presumption in favour of sustainable development*".

129. In order to achieve the sustainable development objective, the NPPF has identified 3 overarching objectives (paragraph 8):

> "*a) **an economic objective** – to help build a strong, responsive and competitive economy, by ensuring that sufficient land of the right types is available in the right places and at the right time to support growth, innovation and improved productivity; and by identifying and coordinating the provision of **infrastructure** (our emphasis);*
>
> *b) **a social objective** – to support strong, vibrant and healthy communities, by ensuring that a sufficient number and range of homes can be provided to meet the needs of present and future generations; and by fostering a well-designed and safe built environment, with accessible services and open spaces that reflect current and future needs and support communities' health, social and cultural well-being; and*
>
> *c) **an environmental objective** – to contribute to protecting and enhancing our natural, built and historic environment; including making effective use of land, helping to improve biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy*."

130. This theme is developed further in Section 10 '*Supporting high quality communications'* of the Achieving Sustainable Development section of the NPPF (paragraphs 114-118) where the government sets out its objectives for national communications planning policy. Paragraph 114 emphasises that advanced, high quality and reliable communications infrastructure is essential for economic growth and social well-being, and that planning policies and decisions should support the expansion of electronic communications networks, including next generation mobile technology, such as the appeal scheme. The appeal scheme will ensure that high quality services and network coverage is continued within the local area.

131. Paragraph 115 encourages electronic communications masts "*should be kept to a minimum* consistent *with the needs of consumers, the efficient operation of the network and providing reasonable capacity for future expansion…. Where new sites are required (such as for new 5G networks, or for connected transport and smart city applications), equipment should be sympathetically designed and camouflaged where appropriate'.*

132. Whilst the appeal site may be a 'new' site, in the sense that it would be deployed where there is currently no base station, it is designed to provide brand-new coverage to the local for Three UK.

In order for the Operator to provide any level of coverage to a particular area, the necessary apparatus must be deployed to enable this service provision, which is supported in paragraph 114 of the NPPF.

133. The Officers Delegated Report includes reference to the NPPF, specifically, paragraphs 8 and 114-118. These sections of the NPPF are also included within this statement, in support of this appeal. The Local Authority's Decision Notice states that the appeal scheme is not compliant with the NPPF, and this non-compliance is given as a reason for refusal. However, no further detail as to how this assertion was reached is provided, with no further justification included within the Officers Delegated Report. The Appellants strongly refute the assertion that the proposal conflicts with the NPPF and have demonstrated in both the application and within this statement that, in fact, the opposite is true, and the proposal is supported fully by the NPPF, specifically Section 10 (Supporting High Quality Communications).

3.2.2 Local Guidance

134. Section 70 of the Town and Country Planning Act 1990 requires planning applications and appeals to be determined having regard to the provisions of the Development Plan and other material considerations, and section 38 of the Planning and Compulsory Purchase Act 2004 requires applications and appeals to be determined in accordance with the Development Plan unless material considerations indicate otherwise.

135. For the purposes of Section 70, the current adopted development plan for Manchester City Council, relevant to the proposal, is The Core Strategy Development Plan 2021-2027 ("The Core Strategy") (adopted July 2012). This document is supported by saved policies from the Unitary Development Plan for the City of Manchester (1995).

136. The Local Authority justifies the refusal of its Prior Approval through assertion of conflict between the Appeal proposal and Policies DM1 (Development Management) and SP1 (Spatial Principles) of The Core Strategy, and saved policy DC17.1 of the Unitary Development Plan.

137. Policy EN1: '*Design Principles and Strategic Character Areas*' is also outlined within the Officers Delegated Report, however, as the appeal scheme's non-compliance with this policy is **not** cited as a reason for refusal, it is not considered necessary to demonstrate compliance with it. As such, it will be discussed no further within this statement.

138. Policy DM1: 'Development Management' of "The Core Strategy" (July 2012) is intended to ensure that new developments contribute to the overall aims of the Core Strategy; which includes "*protection of amenity and local character, environmental standards and practical matters such as access and safety*". The Local Authority have given the appeal scheme's non-compliance with this policy as grounds for refusal. The policy, in its entirety, is broken down into 15 bullet points, 13 of which are included within the Officers Delegated Report. They are repeated below for clarity:

> "*Policy DM 1 states that all development should have regard to the following specific issues for which more detailed guidance may be given within a supplementary planning document:-*

a) *Appropriate siting, layout, scale, form, massing, materials and detail.*
b) *Impact on the surrounding areas in terms of the design, scale and appearance of the proposed development. Development should have regard to the character of the surrounding area.*
c) *Effects on amenity, including privacy, light, noise, vibration, air quality and road safety and traffic generation. This could also include proposals which would be sensitive to existing environmental conditions, such as noise.*
d) *Accessibility: buildings and neighbourhoods fully accessible to disabled people, access to new development by sustainable transport modes.*
e) *Community safety and crime prevention.*
f) *Design for health.*
g) *Adequacy of internal accommodation and external amenity space.*
h) *Refuse storage and collection.*
i) *Vehicular access and car parking.*
j) *Effects relating to biodiversity, landscape, archaeological or built heritage.*
k) *Green Infrastructure including open space, both public and private.*
l) *Flood risk and drainage.*
m) *Existing or proposed hazardous installations".*

139. The bullet points which make up DM1 are not numbered within the Core Strategy, but, for ease of reference, have been numbered (by the Agent) above. Whilst these 13 bullet points are included within the Officers Delegated Report, the Local Authority provides no justification for their inclusion, save for the fact that they state that the appeal scheme does not comply with the policy overall. This is contested by the Appellant, and submit that points d, e, f, g, h, i, j, l and m are not relevant to the appeal scheme. As such, these points will be discussed no further in this statement.

140. Given that the Local Authority provide no clarity on this matter, in either their Decision Notice, or within the Officers Delegated Report, the Appellant can only presume that the Local Authority's inclusion of non-compliance with this policy, as a reason for refusal, relates to points a, b, c, and k. These points will be assessed against the appeal scheme and the Appellant will make the case that the inclusion of this policy as grounds for refusal is unreasonable.

141. The Planning Inspectorate is respectfully requested to acknowledge that policy DM1 is not geared towards the development of telecommunications networks, and the infrastructure that is required to support them. As such, the Appellants submit that such a policy cannot legitimately take into consideration the design constraints that the dictate the size, scale and form of the appeal proposal, or any telecommunications proposal for that matter.

142. However, in terms of a) "*Appropriate siting, layout, scale, form, massing, materials and detail*", this statement has provided a robust justification for the level of apparatus which is proposed, and for the height of the monopole (15m). In terms of appropriate siting, it should be acknowledged that the deployment of any telecommunications apparatus in an area of dense residential housing is likely to have some impact on visual amenity. It is submitted that the best location has been brought forward which minimised the visual impact of the scheme through clever siting – i.e. the positioning of the monopole as far away from the nearest residential property as practicable, allowing it to be off-set from the front of the same property, and also framed within views of mature trees.

143. In terms of layout, scale, form, massing, materials and detail, the apparatus has been reduced to the lowest level of equipment – 3no ground-based cabinets and a 15m monopole. Given that 20m monopoles are now routinely deployed in similar settings, it is considered that the maximum reduction possible has been applied in regard to the appeal scheme. A significant section of this document, titled 'Technical Constraints', paragraphs 112 – 122, as well as within the Supplementary Information document submitted with the original planning application, outline the choice for design and the constraints which are faced in the deployment of any new telecommunications base station.

144. The same principles can be applied to the assessment of the appeal proposal to b) "*Impact on the surrounding areas in terms of the design, scale and appearance of the proposed development. Development should have regard to the character of the surrounding area*". The Appellants have demonstrated within this statement that the apparatus has been 'scaled-down' to the maximum effect, to ensure that the visual impact of the scheme has been reduced as far as practicable. This statement has provided further detail of the measures taken to reduce any perceived harm; i.e. the use of the existing natural environment and the proximity to a row of non-residential shops on Slade Lane – the only non-residential properties within the local area. As discussed above, any new telecommunications installation deployed in any residential area is likely to have some level of visual impact. The Appellants submit that these impacts have been minimised as far as practicable and, when a balanced assessment of the benefits brought forward as part of the scheme are compared to the harm which may be caused, it is considered that the best town planning and environmental solution has been selected.

145. The Officers Delegated Report does not suggest that the appeal scheme would lead to a loss of light, the creation of an unacceptable level of noise or vibration, a reduction in air quality or an unacceptable level of traffic generation. When point c) (of Policy DM1) above, is assessed against the appeal scheme, the only points that could conceivably be assessed against the scheme are those of '*privacy*' and '*road safety*'.

146. As outlined in paragraph 39, the Highways Services offered no objection to the scheme and confirmed that the proposals would "*not cause a distraction to passing vehicles and would not give rise to forward visibility issues*".

147. As such, the only remaining point of c), that needs to be assessed against the appeal scheme, is that of loss of privacy. The Local Authority has clearly determined that the perceived loss of privacy for the residential property opposite the appeal site is of greater importance than the shared public benefits which will be brought forward as part of the scheme. Examples of similar appeals have been provided within this statement, in particular paragraphs 98 – 100, which relate to a taller and more robust telecommunications base station, which also sits in closer proximity to residential housing than that proposed at the appeal site (Appeal Ref: APP/K2610/W/21/3280694). That that appeal was allowed, is significant, as are the Planning Inspectors comments within the Decision Notice (paragraph 98). Should the same criteria be applied to this appeal, then the proposed development should be allowed.

148. The principles of Policy DM1 are inextricably linked to the aims of The Core Strategy, which includes an improvement of lives and social interaction within the Local Authority area. The resulting

improvement in connectivity, coverage, and capacity, for the Appellants mobile network, in the local area, is of significance to improving lives and social interaction within the area. Were this apparatus to be deployed in any residential area within the Local Authority's jurisdiction, it would be expected to result in some level of visual impact. The Appellants have carefully and considerately selected what they believe to be the best and most appropriate solution. Whilst Policy DM1 is acknowledged by the Appellant, and the aims it strives to achieve are understood, it is unlikely that any 'new' development within an already built-up area is able to fully comply with all elements of the policy. As such, the best option should be brought forward and considered acceptable, where it is clear than efforts have been made to reduce the loss of visual amenity.

149. In terms of k) (of Policy DM1), it is submitted by the Appellant that, as the proposed apparatus is positioned on the pedestrian footway, then this will result in no loss of open space, as it would if the appeal site was moved back circa 1metre onto the grass area. Furthermore, the positioning of the proposed apparatus adjacent to the open space is considered to be no different, in terms of loss of enjoyment of this area, as the approved installation of a bus shelter on the adjacent border (on Slade Lane) or any streetlighting column.

150. The Appellant notes that, included within the Officers Delegated Report, the Local Authority states that the proposal is "*a very tall structure that is mainly seen in the context of the adjacent open land, rather than a backdrop of buildings, and other street furniture,* ***where the monopole might not appear so imposing****. As such, it is considered that the proposed installation would dominate this location and the development, by reason of its height, siting and appearance, would be unduly harmful to the character and visual amenity of the streetscene and the visual amenity of surrounding residential properties, as well as impacting on the visual appeal of the green space*" (emphasis added).

151. The Appellant submits that the above statement is entirely subjective, and, if this suggestion were to be implemented as part of this scheme, then that would surely result in non-compliance with policy DM1 and lead to an unacceptable loss of privacy. As outlined in paragraphs 8, 9 and 10 of this statement, the appeal scheme was specifically positioned at the appeal site to ensure that it was not in direct view of any residential property, thereby minimising the visual impact as far as practicable. Given the nature of the surrounding area, as discussed above, the Appellants successful identification of a site which did not sit directly outside a residential property within this area was challenging. That the Officers Delegated Report suggests that a "*backdrop of buildings*" may result in the appeal scheme not appearing "*so imposing*" is in direct conflict with reason for refusal as given in the Local Authority's Decision Notice, as well as being in direct conflict with Policy DM1 on the whole.

152. The Appellant submits that it is unachievable to utilise a "*backdrop of buildings*" within the local area (which is made-up mostly of two-storey residential properties) to reduce the visual impact of the appeal scheme, without resulting in harm, and loss of amenity, to said buildings and their inhabitants.

153. If the appeal site was repositioned outside other 'buildings', of which there are only residential within the local area, even the upper floor of the non-residential buildings on Slade Lane appear to be inhabited, then any other location would surely fall foul of policy DM1. Essentially, the Local

Authority are suggesting that no telecommunications development is considered appropriate within the local area, which not only falls foul of the NPPF, and other planning guidance, but the Local Authority's own aims for the future.

154. In terms of k) (of Policy DM1), it is submitted by the Appellant that, as the proposed apparatus is positioned on the pedestrian footway, then this will result in no loss of open space, as it would if the appeal site was moved back circa 1metre onto the grass area. Furthermore, the positioning of the proposed apparatus adjacent to the open space is considered to be no different, in terms of loss of enjoyment of this area, as the approved installation of a bus shelter on the adjacent border (on Slade Lane).

155. It is submitted by the Appellant, that when the information provided in paragraphs 138 – 154 is assessed, then the inclusion of non-compliance with policy DM1 as grounds for refusal is unreasonable.

156. Policy SP1: 'Spatial Principles' of "The Core Strategy" (July 2012) lists the key principles which will help guide the strategic development of Manchester to 2027. It provides the Core Development Principles, which are as follows:

"*Development in all parts of the City should:-*

- *Make a positive contribution to neighbourhoods of choice including:-*
  - *creating well designed places that enhance or create character.*
  - *making a positive contribution to the health, safety and wellbeing of residents*
  - *considering the needs of all members of the community regardless of age, gender, disability, sexuality, religion, culture, ethnicity or income.*
  - *protect and enhance the built and natural environment.*
- *Minimise emissions, ensure efficient use of natural resources and reuse previously developed land wherever possible.*
- *Improve access to jobs, services, education and open space by being located to reduce the need to travel and provide good access to sustainable transport provision"*.

157. The Local Authority have given the appeal scheme's non-compliance with this policy as grounds for refusal and include the seven Core Development Principles within the Officers Delegated Report. Not all of these points are considered relevant to telecommunications development. However, the over-arching aim of the policy is to make positive contributions to any given neighbourhood and provide benefits and opportunity to said neighbourhood.

158. It is therefore submitted that this is exactly what is achieved through the development of high-quality telecommunications networks, as advocated within the NPPF. In terms of the seven bullet points listed within Policy SP1, this document has provided a robust justification for the exact siting of the proposed apparatus. The social, economic and environmental benefits that are brought forward through the provision of new mobile coverage, capacity and connectivity to residential neighbourhoods will both enhance and create character for residents. As outlined in this document, public dependence on mobile networks is at an unprecedented level. If mobile networks are not improved within a particular area, it could be suggested that this will in fact be in complete conflict with SP1, in that these neighbourhoods ultimately become disadvantaged when compared to other

neighbourhoods which benefit from the most modern connectivity available (i.e. 4G and 5G). It is therefore submitted that a lack of the best available mobile connectivity is inadvertently achieving the opposite of '*enhancing character*'.

159. Furthermore, the '*health, safety and wellbeing of residents*' is assisted via the provision of services which allows enhanced social benefits, that undoubtedly assists in making a positive contribution to public health, and, as is becoming increasingly prominent, public mental health. Given that during 2020 and 2021, the public experienced long periods of time where social interaction was limited to 'virtual only', providing access to the most modern mobile networks services is considered of vital importance. The Covid-19 pandemic emerged in 2020 and dictated every single aspect of public life for a considerable period of time. There is no way of knowing if another global pandemic will emerge and have a similar effect. Whilst this may seem unlikely, retrospectively nothing seemed more unlikely at the start of 2020 than three national lockdowns, a global travel ban, and being able to leave our homes for 1 hour per day. It is not suggested that the deployment of the appeal scheme is necessary to ensure that all eventualities are covered and that any future national lockdowns are pre-empted, but rather that it is a factor which was not a consideration when SP1 was formulated or adopted. The 'virtual only' interaction which became so evident during 2020 and 2021 has continued into 2022, which has been outlined in paragraphs 57 – 83, showing that mobile data consumption has continued to grow year-on-year. In order for this demand to be met, the necessary infrastructure must be deployed, and, given that these interactions typically take place in a residential setting, the necessary infrastructure must be deployed within a residential setting. These services are essential to the health and wellbeing of neighbourhood residents and it is submitted by the Appellant that this appeal scheme is wholly compliant with the aims of the SP1.

160. Whilst the apparatus, i.e. a monopole and associated ground-based equipment cabinets, cannot be considered to '*protect and enhance the built environment*', it is submitted that the **service** that this appeal scheme will provide will do just that. Enhanced connectivity, capacity and coverage in a particular area opens up new economic and social avenues, certainly assisting the move from office-based only employment, to a more hybrid work-from-home employment. Without the infrastructure to provide this service being in place, this would simply not be possible. Twenty-five or thirty years ago, 'working from home', as a concept, would have been highly unachievable. Now, however, some employment is openly advertised with a 'work-from-home' slogan. The ability to work-from-home, via improved connectivity, will offer neighbourhood residents improved access to jobs, services, and education, as advocated by SP1.

161. In a time where the public appear to be more aware of the tolls that private car ownership and long daily commutes are taking on the Earth's environment, the ability to work-from-home, and the ability to eradicate the daily commute from their behaviours, is certainly considered to '*protect and enhance the built environment',* as required by SP1. Without the proposed apparatus, this would not be possible. This offers a segue into one of the other points which makes up SP1, this being that all deployment should '*minimise emissions'*. The provision of brand-new 3G, 4G and 5G network services to this area of Burnage will offer the ability for more people to create a 'virtual office' and work-from-home. As such, this will lead to a reduced level of car travel, during peak times, and therefore a potential reduction in traffic congestion, and ultimately a reduction in both '*emissions*' and '*the need to travel'*, as per SP1.

162. The appeal site, positioned on a pedestrian footway, will result in no loss of open space, or previously undeveloped land.

163. The Local Authority include SP1: 'Spatial Principles', and the appeal scheme's non-compliance with it, as ground for refusal. However, as outlined in the preceding paragraphs, the Appellant submits that the appeal scheme is wholly compliant with SP1, and its aims, and the Local Authority's inclusion of this policy, as grounds for refusal, is unreasonable.

164. The appeal scheme's non-compliance with saved policy 'DC17 Telecommunications' is given as grounds for refusal. For completeness, this policy states the following:

> "*Applications for telecommunications developments will normally be approved if the Council can be satisfied that the development has been sited and designed to minimise its impact on residential amenity and in environmentally sensitive areas. Wherever possible, the Council will expect the potential of existing buildings and masts, including the sharing of such facilities, to be fully explored before agreeing to additional separate development*".

165. This policy, albeit a 27-year-old policy, is used to assess the acceptability of modern-day telecommunications sites within the Local Authority area. The supporting justification which accompanies this policy states that "*The Council recognises the need for **Manchester to be at the forefront** in the field of telecommunications. The Council therefore starts from a **presumption in favour** of new development and investment in the telecommunication systems serving the City*" (emphasis added).

166. Our dependence on the established mobile networks is now at an unprecedented level, as outlined in paragraphs 72 – 78 of this document, whilst the data provided in paragraph 82 shows a clear trend that network connectivity is no longer considered to be a luxury, but rather an expectation and a direct need.

167. The proposed apparatus only serves one function – to provide communication services and mobile network coverage to the local area. The equipment has **no** other function. As such, the appearance of the equipment, and the height of the equipment, is dictated purely by functionality and technical constraints. As outlined within this document, as well as within the original planning application, the proposed apparatus is of the smallest size, scale and height that can achieve the desired network coverage to the local area. As such, all steps have been taken to minimise the visual impact of the scheme through both siting and appearance, as required within GPDO Prior Approval applications, and both local and national planning policy.

168. There are no opportunities to 'share' existing apparatus, and, as the surrounding area consists of two-storey residential properties, there is no opportunity to deploy the apparatus on any existing rooftop or structure.

169. As per Policy DC17, the proposed development is **not required to avoid any and all visual impact**, but rather to ensure that it has been designed to "*minimise its impacts on residential*

amenity". The Appellants submit that the appeal proposal achieves this and justification has been demonstrated in this document. As such, the Appellant's contest the inclusion of this Policy, and the assertion that the appeal scheme does not comply with it.

170. The apparatus that makes up the appeal scheme should be assessed as any other piece of single-function street furniture – i.e. a street lighting column. The Appellant submits that the most appropriate way to integrate a telecommunications installation into the surrounding area is to utilise the existing natural, and built, environment to reduce its prominence. This position is supported by the Code of Practice 2022 and is exactly what has been achieved with the appeal scheme. The proposed 15m monopole would be positioned in close proximity to mature trees, and therefore framed in these views.

171. Given that apparatus identical to that which is proposed as part of the appeal scheme, is often seen within suburban areas, and on pedestrian footways, **without** the benefit of screening, and/or a backdrop, identifying a suitable location which provides any element of screening can only assist in reducing the visual impact of any proposal.

172. That being said, any development at any location will have some level of visual impact on the local area. The appeal proposal is solely designed to provide a service to the local area. The deployment of the infrastructure to provide this service is unavoidable, as without it, there can be no network. The assessment that must be undertaken is clear – do the public benefits of new network connectivity, coverage, and capacity, to the local area outweigh any visual impact that the proposed development may cause. The Appellants submit that the provision of network coverage to the local area is of paramount importance. Additionally, the Appellants submit that the assessment undertaken by the Local Authority did not take into consideration the public benefits that will be brought forward as part of the appeal scheme.

173. The design of the proposed structure is solely dictated by functionality and technical parameters. The Appellants submit that the design is appropriate and that is borne out by the fact that this type of apparatus is now widely accepted within suburban and residential areas across the UK.

174. The Appellants submit that a strong case has been made for this appeal to be allowed and that the refusal of the application on the grounds cited is not defensible.

Section 4: Summary

175. The Appellants have provided evidence of the benefits of high quality communications infrastructure in terms of boosting economic growth, promoting social inclusion and enhancing the provision of local community facilities and services. It is submitted that the Local Authority did not give sufficient weight to this need when balancing the limited impact of the appeal proposal on the wider area against the increasing importance of providing reliable digital connectivity, in the wider public interest. There was no reference to any of these benefits in either the Local Authority's Decision Notice, or the Officers Delegated Report. It could therefore be interpreted that these benefits did not form part of the Local Authority's assessment or decision-making process, and that

the visual impact of the appeal scheme was the only factor that was considered, rather than the balanced assessment advocated within the NPPF of benefit vs harm.

176. The Appellants have addressed the reasons for refusal within this document, which relate to the perceived visual impact of the appeal scheme, its impact on streetscene and the nearby residential properties, and the Local Authority's suggestion that the scheme, and the impact that it will have, has not been minimised as far as practicable.

177. As outlined in this document, the demand on the existing mobile networks is at an unprecedented level, with mobile data consumption now at its highest monthly figure in history. This is supported by the Ofcom Connected Nations Reports which are referred to at various points of this statement. In order to provide the next level of technological advancement – i.e. 5G connectivity, capacity and coverage – additional base stations are required across the UK. The appeal scheme will provide 5G coverage for Three UK to this area of Burnage. This will benefit residents, businesses, and people who have now elected to work-from-home, post-pandemic. Increases in online shopping, gaming, streaming services direct to handset, video-calling, and socialising, in general, require the necessary infrastructure to be in place to provide services which enable these activities to take place. Without this infrastructure, none of the above will be achievable. Ensuring that mobile connectivity is continually enhanced and improved, via 5G, is a direction of travel which is supported by Central Government.

178. It has been demonstrated that the appeal proposal, by reason of its appropriate siting and design, would not result in an unacceptable or detrimental impact on the character or appearance of the local area and that every effort has been made to reduce any impact on the surrounding area, as per both local and national planning policy.

179. As such, the Appellants submit that the scheme is viable from a town planning perspective and that any impact on visual amenity is considered to be outweighed by the social, economic and environmental benefits which would be brought forward as part of the deployment of this base station.

180. For these reasons, the Inspector is respectfully requested to allow the appeal and grant planning consent for the proposed development.

Appendices	
1	• Decision Notice – 133822/TEL/2022 • Officers Delegated Report – 133822/TEL/2022 • Planning Drawings, Rev A • Site Location Plan, Rev A
2	• Fixing the Foundations – Creating A More Prosperous Nation • 'Connected Future' – National Infrastructure Commission (2016) • Digital Connectivity In London (2017) • Communications Market Report (2019) • Connected Nations 2020 – UK Report • Connected Nations 2021 – UK Report • Connected Nations UK Report – Spring 2022
3	Relevant appeal decisions: • APP/Q3305/W/18/3206555 – Vodafone Vs. Mendip District Council. • APP/L1765/W/18/3197522 – CTIL and Vodafone Vs Winchester City Council. • APP/R5510/W/16/3143922 – CTIL and Telefonica UK Ltd Vs the Council of the London Borough of Hillingdon. • APP/K3605/W/19/3243927 – EE Ltd and H3G UK Ltd Vs Elmbridge Borough Council. • APP/K2610/W/21/3280694 – Mobile Broadband Network Limited vs Broadland District Council. • APP/R5510/W/21/3269903 – MBNL Limited Vs London Borough of Hillingdon Council. • APP/E2205/W/20/3261389 – Telefonica UK Limited Vs Ashford Borough Council. • APP/J4423/W/21/3268791 – MBNL Limited Vs Sheffield City Council. • APP/Q5300/W/16/3142885 – CTIL and Telefonica UK Limited vs the Council of the London Borough of Enfield.

MANCHESTER CITY COUNCIL

Planning

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Telecoms Dalcour Maclaren
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Weston On The Green
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Date: 8 July 2022

Dear Sir/Madam,

Town & Country Planning (General Permitted Development Order) (England) 2015 (as amended) Schedule 2, Part 16
Application No: 133822/TEL/2022
Installation of 15 metre high monopole tower to support antennas, with wraparound cabinet at base and associated freestanding cabinets at Pavement Close To The Intersection Of Burnage Lane & Cringle Hall Road, Manchester, M19 2JE

I write with reference to the above application and advise you that prior approval will be required for the siting and appearance of the proposed apparatus.

In this case, prior approval is **refused** for the following reason(s):

1) The City Council is not satisfied that this development has been sited and designed to minimise the impact upon visual amenity. The proposed telecommunication installation by reason of its height, siting and appearance, would be unduly harmful to the character and visual amenity of the streetscene and nearby residential properties, as well as the adjacent green space off Cringle Hall Road. The proposed telecommunications equipment would therefore be contrary to policies DM1 and SP1 of the Manchester Core Strategy (2012), saved policy DC17.1 of the Unitary Development Plan for the City of Manchester (1995) and the National Planning Policy Framework (NPPF).

Should you wish to discuss this matter any further please contact Ian Jarvis.

Yours faithfully,

Julie Roscoe
Director of Planning, Building Control & Licensing

MANCHESTER CITY COUNCIL

Planning

Growth & Development

Delegated officer report for planning application

Application no.	133822/TEL/2022
Date registered valid:	19 May 2022
Proposal:	Installation of 15 metre high monopole tower to support antennas, with wraparound cabinet at base and associated freestanding cabinets
Address:	Pavement Close To The Intersection Of Burnage Lane & Cringle Hall Road, Manchester, M19 2JE
Ward(s):	Burnage Ward
Applicant:	Hutchison 3G UK Ltd 450 Longwater Avenue, Green Park, Reading, RG2 6GF
Agent (if any):	Telecoms Dalcour Maclaren Dalcour Maclaren 1 Staplehurst Farm, Weston On The Green, OX25 3QU
Case officer:	Ian Jarvis Tel: 0161 234 4079 Email: ian.jarvis@manchester.gov.uk
Recommendation:	Refuse
Date of recommendation:	8 July 2022

Application details

Type of application: Telecommunication Application

Development type: Notifications

Date of site visit:

Standard consultations:
Printed: 25 May 2022 Expired: 15 June 2022

Neighbour notifications
Printed: 25 May 2022 Expired: 15 June 2022

Site notice
No site notice has been produced

Press advert
Published: 31 May 2022 Expired: 21 June 2022

Departure from Development Plan: No

Environmental Statement: Not required

Description of site/building

Listed building: Not applicable

Conservation area:

Tree Preservation Order:

This application relates to an area of pavement, on the northern side of Cringle Hall Road, close to the junction with Burnage Lane. there is a an area of open grassland, to the north of the site, and, other than some commercial properties to the north-east, the area is predominantly residential.

The submitted application seeks prior approval for the installation of a 15 metre high telecommunications column supporting antennas, with wraparound cabinet at base and associated freestanding cabinets adjacent to the column.

The proposal has been advertised in the press, as development affecting a right of way and development in the public interest.

Consultations & Notification Responses

Local residents - One objection has been received, from a local resident, for the following reasons;

- They are the owners of the property opposite this proposed 15 meter high monopole, which will be right in front of their view from every window in their home. It will also be the view from their garden. This will decrease the value of their home and living conditions.

- How can such a mast be considered on a residential road/ There are plenty of areas not opposite residential homes, where a mast can be erected. Just across the road are shops that it wont affect.

In addition, a petition has been received from the Ferguson Court Residents Association, signed by 54 local residents. They consider that the proposed development would have a detrimental impact on their lives, on the grounds of safety, appearance and TV interference.

Highway Services - Makes the following comments:

Both the mast and associated antennas and cabinets appear to be placed at the back of the adopted footway. However, it is unclear how large the equipment is and how much footway will be used. Highways would be accepting in-principle of these proposals subject to the final positioning of apparatus being sufficient to maintain the minimum desirable clearance of 2m to any adjacent street furniture and the edge of carriageway.

It is accepted by highways that the proposals would not cause a distraction to passing vehicles and would not give rise to forward visibility issues.

Strategic Area and Citywide Development Manager - Recommends that conditions are attached, to any permission, in relation to construction management hours and acoustic insulation of the equipment.

Issues

Town and Country Planning (General Permitted Development) (England) (Amendment) (No.2) Order 2016

The proposal falls within Part 16, Class A - 'Electronic communications code operators', of the above regulations. This requires that Local Planning Authorities assess whether prior approval is required for the siting and appearance of the development.

The development can be assessed, under this legislation as:
- The existing building is between 15 and 30 metres high and the height of the equipment, taken by itself, would be 7.95 metres and therefore would be less than 8 metres.
- There would be no more than 5 antenna systems on the building (whilst there would be 8 antennas, in total, on the building, the legislation describes an antenna system as a set of antennas installed on a building and does not therefore restrict permitted development rights to 5 individual antennas)
- The building is not listed.

National Planning Policy Framework (July 2021) - Sets out the Government's Planning Policies for England and how these should be applied. It states that the purpose of the planning system is to contribute to the achievement of sustainable development. It states that achieving sustainable development means that the planning system has 3 overarching objectives:

An economic objective - to help build a strong, responsive and competitive economy, by ensuring that sufficient land, of the right types is available in the right places and at the right time to support growth, innovation and improved productivity; and by identifying and coordinating the provision of infrastructure;

A social objective - to support strong, vibrant and healthy communities, by ensuring that a sufficient number and range of homes can be provided to meet the needs of present and future generations; and by fostering well-designed, beautiful and safe places, with accessible services

and open spaces that reflect current and future needs and support communities' health, social and cultural well-being; and

An environmental objective - to protect and enhance our natural, built and historic environment; including making effective use of land, improving biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change including moving to a low carbon economy

The Framework has been related to the proposed development, with particular emphasis given to the following:

Section 10 Supporting high quality communications infrastructure - The following paragraphs are considered to be relevant:

i. Paragraph 114 - States that advanced, high quality and reliable communications infrastructure is essential for economic growth and social well-being. Planning policies and decisions should support the expansion of electronic communications networks, including next generation mobile technology (such as 5G) and full fibre broadband connections. Policies should set out how high quality digital infrastructure, providing access to services from a range of providers, is expected to be delivered and upgraded over time; and should prioritise full fibre connections to existing and new developments (as these connections will, in almost all cases, provide the optimum solution).

ii. Paragraph 115 - The number of radio and electronic communications masts, and the sites for such installations, should be kept to a minimum consistent with the needs of consumers, the efficient operation of the network and providing reasonable capacity for future expansion. Use of existing masts, buildings and other structures for new electronic communications capability (including wireless) should be encouraged. Where new sites are required (such as for new 5G networks, or for connected transport and smart city applications), equipment should be sympathetically designed and camouflaged where appropriate.

iii. Paragraph 117 - States that applications for electronic communications development (including applications for prior approval under the General Permitted Development Order) should be supported by the necessary evidence to justify the proposed development. This should include:

(a) the outcome of consultations with organisations with an interest in the proposed development, in particular with the relevant body where a mast is to be installed near a school or college, or within a statutory safeguarding zone surrounding an aerodrome, technical site or military explosives storage area; and

(b) for an addition to an existing mast or base station, a statement that self-certifies that the cumulative exposure, when operational, will not exceed International Commission guidelines on non-ionising radiation protection; or

(c) for a new mast or base station, evidence that the applicant has explored the possibility of erecting antennas on an existing building, mast or other structure and a statement that self-certifies that, when operational, International Commission guidelines will be met.

The Core Strategy Development Plan Document 2012 -2027 ("the Core Strategy") was adopted by the City Council on 11th July 2012. It is the key document in Manchester's Local Development Framework. The Core Strategy replaces significant elements of the Unitary Development Plan (UDP) as the document that sets out the long term strategic planning policies for Manchester's future development.

A number of UDP policies have been saved until replaced by further development plan documents to accompany the Core Strategy. Planning applications in Manchester must be decided in accordance with the Core Strategy, saved UDP policies and other Local Development Documents.

Policy SP1 identifies the City Council's Core Development Principles and states that development in all parts of the City should:-

Make a positive contribution to neighbourhoods of choice including:-
- Creating well designed places that enhance or create character
- Making a positive contribution to the health, safety and wellbeing of residents
- Considering the needs of all members of the community regardless of age, gender, disability, sexuality, religion, culture, ethnicity or income.
- Protect and enhance the built and natural environment

Minimise emissions, ensure efficient use of natural resources and reuse previously developed land wherever possible.

Improve access to jobs, services, education and open space by being located to reduce the need to travel and provide good access to sustainable transport provision.

Policy EN1 relates to design principles and strategic character areas and states that all development in Manchester will be expected to follow the seven principles of urban design listed below:
- Character: a place with its own identity
- Continuity and enclosure: a place where public and private places are clearly distinguished
- Quality of the public realm: a place with attractive, and successful outdoor areas
- Ease of movement: a place that is easy to get to and move through
- Legibility: a place that has a clear image and is easy to understand
- Adaptability: a place that can change easily
- Diversity: a place with variety and choice

Policy DM 1 states that all development should have regard to the following specific issues for which more detailed
guidance may be given within a supplementary planning document:-
- Appropriate siting, layout, scale, form, massing, materials and detail.
- Impact on the surrounding areas in terms of the design, scale and appearance of the proposed development. Development should have regard to the character of the surrounding area.
- Effects on amenity, including privacy, light, noise, vibration, air quality and road safety and traffic generation. This could also include proposals which would be sensitive to existing environmental conditions, such as noise.
- Accessibility: buildings and neighbourhoods fully accessible to disabled people, access to new development by sustainable transport modes.
- Community safety and crime prevention.
- Design for health.
- Adequacy of internal accommodation and external amenity space.
- Refuse storage and collection.
- Vehicular access and car parking.
- Effects relating to biodiversity, landscape, archaeological or built heritage.
- Green Infrastructure including open space, both public and private.
- Flood risk and drainage.
- Existing or proposed hazardous installations.

Unitary Development Plan - The site is unallocated in the plan.

Saved policy DC17 relates to telecommunications and states that the council should be satisfied that the development has been sited and designed to minimise its impact on residential amenity and in environmentally sensitive areas.

Siting/design - It is noted that there are a number of street lighting columns, in the vicinity of the site along with some high trees on the adjacent pavement and grassland. There are no other telecommunications masts in the immediate vicinity of the site limiting any potential for mast sharing.

The applicant has applied the sequential test to the provision of new and upgraded telecoms equipment, and they do not feel that there is an alternative suitable location and that the new installation is considered the best technical and environmental solution which will enable the operator to address the current coverage deficiency in this area.

Having assessed the proposal, it is considered that the development would give rise to a harmful impact to the visual amenity of the area. The proposed location is next to a large area of open land, and it is considered that the monopole would be seen as an imposing/strident feature against that backdrop. The applicants feel, as the monopole is 15 metres high, they have made efforts to make the development sympathetic to its location, but the proposal is nevertheless a very tall structure that is mainly seen in the context of the adjacent open land, rather than a backdrop of buildings, and other street furniture, where the monopole might not appear so imposing. As such, it is considered that the proposed installation would dominate this location and the development, by reason of its height, siting and appearance, would be unduly harmful to the character and visual amenity of the streetscene and the visual amenity of surrounding residential properties, as well as impacting on the visual appeal of the green space,

The Council is mindful of the benefits that such developments bring, but in this case, it is not considered that this outweighs the substantial visual harm that this proposal will cause in this particular location.

Residential amenity - There are a significant number of residential properties, in close proximity to the site, and it is considered that they currently have pleasant views over an area of open grassland, that would be detrimental impacted by the proposed development. As such, it is considered that the proposed development would have a harmful impact upon their visual and residential amenity.

Highways - All works are on an existing rooftop with no obvious line of sight, for oncoming traffic and it is not considered that the proposal would have any impact upon highway users.

Health and safety - The proposal accords with all relevant health and safety requirements, including the guidelines of the International Commission for Non-Ionising Radiation Protection (ICNIRP) as adopted in the EU Council Recommendation of 12 July 1999 on the limitation of exposure to the general public to electromagnetic fields. A declaration of conformity with ICNIRP Public Exposure Guidelines has been submitted with the application and meets guidelines in terms of health aspects that a local planning authority does not need to give further consideration to health aspects given an ICNIRP has been submitted.

Human Rights Act 1998 considerations

This application needs to be considered against the provisions of the Human Rights Act 1998. Under Article 6, the applicants (and those third parties, including local residents, who have made representations) have a right to a fair hearing and to this end the local planning authority must give full consideration to their comments.

Protocol 1 Article 1, and Article 8 where appropriate, confer(s) a right of respect for a person's home, other land and business assets. In taking account of all material considerations, including Council policy as set out in the Core Strategy and saved polices of the Unitary Development Plan, the Director of Planning, Building Control & Licensing has concluded that some rights conferred by these articles on the applicant(s)/objector(s)/resident(s) and other occupiers and owners of nearby land that might be affected may be interfered with but that that interference is in accordance with the law and justified by being in the public interest and on the basis of the planning merits of the development proposal. She believes that any restriction on these rights posed by the recommendation given is proportionate to the wider benefits of and that such a decision falls within the margin of discretion afforded to the Council under the Town and Country Planning Acts.

Recommendation: Refuse

Article 35 Declaration

Officers have worked with the agent in a positive and proactive manner based on seeking solutions to problems arising in relation to dealing with the application. In this instance a solution that was acceptable to both the Local Planning Authority and the applicant could not be reached as the nature of the proposal was considered to be unacceptable in this location. The applicant was invited to withdraw, with a view to discussing alternative locations, but this was not accepted by the applicant.

Condition(s) to be attached to decision for approval OR Reasons for recommendation to refuse

1) The City Council is not satisfied that this development has been sited and designed to minimise the impact upon visual amenity. The proposed telecommunication installation by reason of its height, siting and appearance, would be unduly harmful to the character and visual amenity of the streetscene and nearby residential properties, as well as the adjacent green space off Cringle Hall Road. The proposed telecommunications equipment would therefore be contrary to policies DM1 and SP1 of the Manchester Core Strategy (2012), saved policy DC17.1 of the Unitary Development Plan for the City of Manchester (1995) and the National Planning Policy Framework (NPPF).

Appendix 1 – List of consultees & neighbours notified

Highway Services
Environmental Health

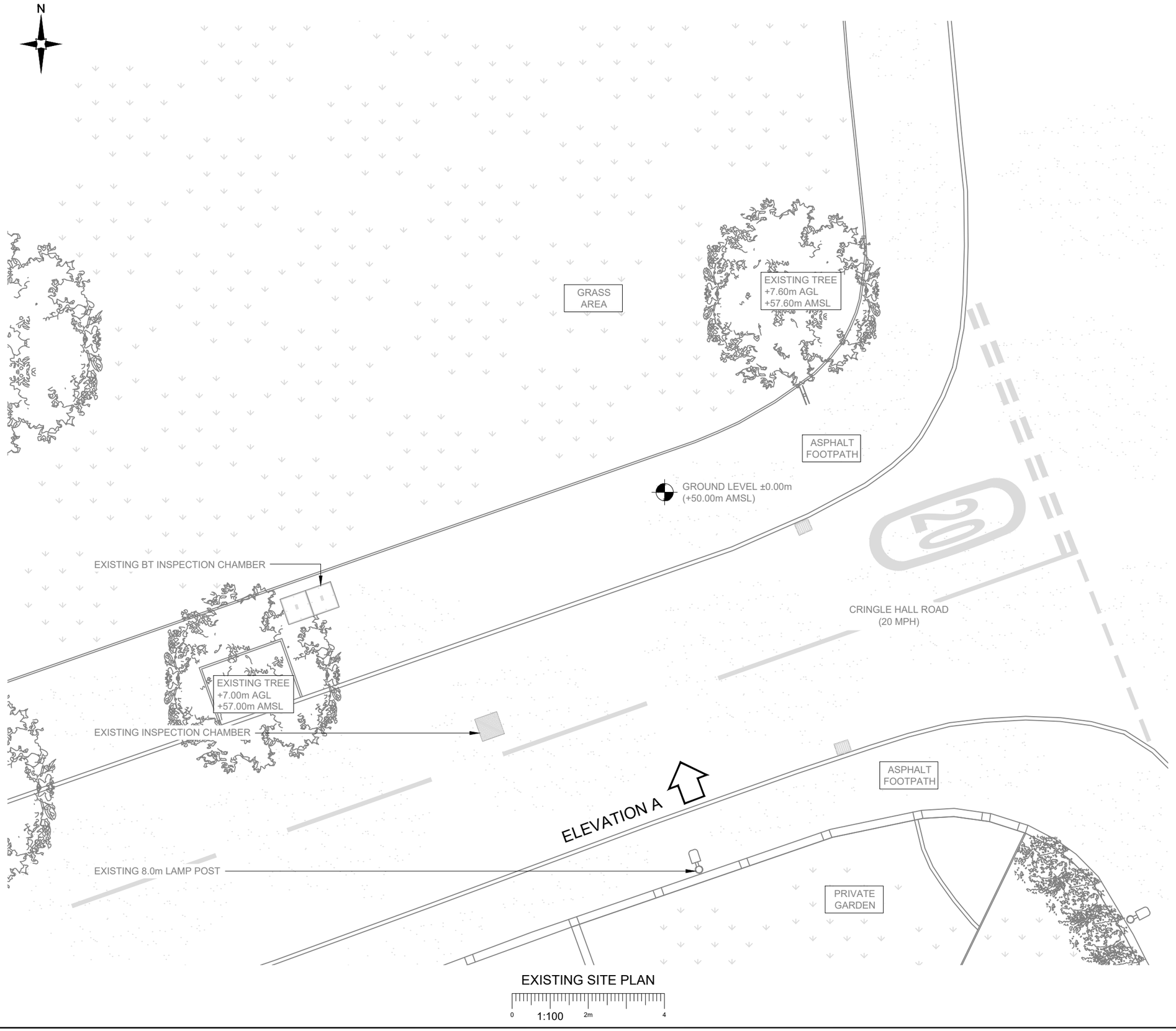
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Flat 232, Ferguson Court, 2 Acorn Close, Manchester, M19 2HS
Flat 231, Ferguson Court, 2 Acorn Close, Manchester, M19 2HS
Flat 229, Ferguson Court, 2 Acorn Close, Manchester, M19 2HS
7 Cringle Hall Road, Manchester, M19 2HU
5 Cringle Hall Road, Manchester, M19 2HU
3 Cringle Hall Road, Manchester, M19 2HU
1 Cringle Hall Road, Manchester, M19 2HU
299 Slade Lane, Manchester, M19 2HR
3 Acorn Close, Manchester, M19 2HS
1 Acorn Close, Manchester, M19 2HS
Flat 2, 100 Milwain Road, Manchester, M19 2PR
Flat 1, 100 Milwain Road, Manchester, M19 2PR
First Floor, 297 Slade Lane, Manchester, M19 2HR
Ground Floor, 297 Slade Lane, Manchester, M19 2HR
390 Slade Lane, Manchester, M19 2HT
Flat 8, 75 Milwain Road, Manchester, M19 2PT
Flat 261, Ferguson Court, 2 Acorn Close, Manchester, M19 2HS
Flat 258, Ferguson Court, 2 Acorn Close, Manchester, M19 2HS
Flat 256, Ferguson Court, 2 Acorn Close, Manchester, M19 2HS
Flat 240, Ferguson Court, 2 Acorn Close, Manchester, M19 2HS
Flat 238, Ferguson Court, 2 Acorn Close, Manchester, M19 2HS
Flat 235, Ferguson Court, 2 Acorn Close, Manchester, M19 2HS
Flat 233, Ferguson Court, 2 Acorn Close, Manchester, M19 2HS
Flat 230, Ferguson Court, 2 Acorn Close, Manchester, M19 2HS
Flat 228, Ferguson Court, 2 Acorn Close, Manchester, M19 2HS
12 Burnage Lane, Manchester, M19 2HX
297 Slade Lane, Manchester, M19 2HR
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Flat 9, 75 Milwain Road, Manchester, M19 2PT

Flat 7, 75 Milwain Road, Manchester, M19 2PT
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Flat 4, 75 Milwain Road, Manchester, M19 2PT
Flat 3, 75 Milwain Road, Manchester, M19 2PT
Flat 2, 75 Milwain Road, Manchester, M19 2PT
Flat 1, 75 Milwain Road, Manchester, M19 2PT
Flat 260, Ferguson Court, 2 Acorn Close, Manchester, M19 2HS
Flat 259, Ferguson Court, 2 Acorn Close, Manchester, M19 2HS

Appendix 2 – Planning constraints

Article 4 Direction - Removal Of PD Rights Change Of Use From Class C3 To Class C4
Aircraft Safeguarding Zone - Aircraft Safeguarding Zone - All Exceeding 90M
Coal Authority - Surface Coal Resources - Name: Coal bearing strata at surface
Flood Zones Type 2 (low to medium risk) -
Susceptible to Surf Water Flood (Less) -
Susceptible to Surf Water Flood (Middle) -
Area Team Boundary - Name: NORTH

V 1.8



100mm

50mm

10mm

NOTES:

1. ALL DIMENSIONS IN MM UNLESS OTHERWISE NOTED.

REV	MODIFICATION	BY	CH	DATE
A	Issued for Planning	RSD	RWB	27.10.21

CK Hutchison Networks (UK) Limited
Great Brighams Mead,
Vastern Road, Reading,
Berkshire, England,
RG1 8DJ

Design Consultant & Principal Contractor:

Great British Communications
Lapwing House, Block 3 Forward Point,
Tan House Lane, Widnes, Cheshire, WA8 0SL
t. 44 (0)151 420 4128
www.gbcservices.co.uk

Site Name:
CRINGLE HALL ROAD

3UK Nominal ID:
MAN19864

Address:
CRINGLE HALL ROAD
BURNAGE
MANCHESTER
GREATER MANCHESTER
M19 2JE

Title:
100 EXISTING SITE PLAN

Project:
UNILATERAL SW

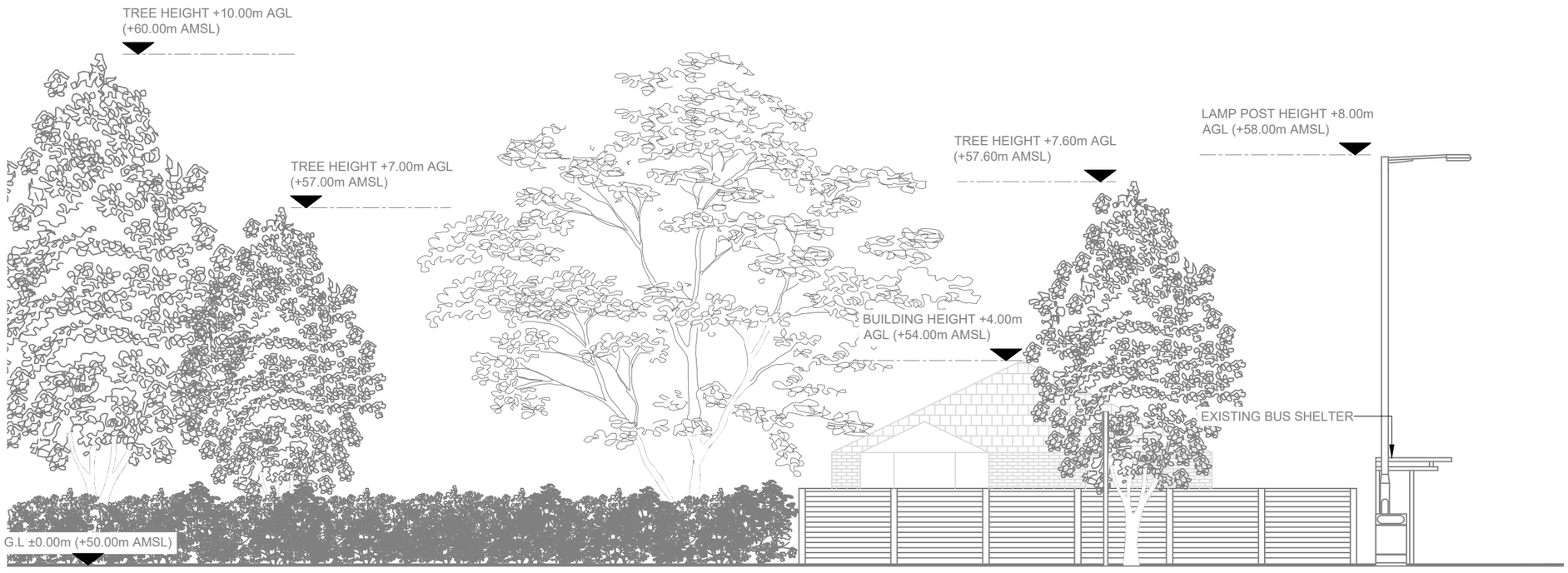
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MBNL/TM/H3G Cell ID:
TBC/TBC/M1267

Drawing No:
MAN19864_TBC_TBC_M1267_GA_REV_A

Issue:
A

V 1.8



EXISTING ELEVATION A

0 1:100 2m 4

100mm 50mm 10mm

NOTES:

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CRINGLE HALL ROAD

3UK Nominal ID:
MAN19864

Address:
CRINGLE HALL ROAD
BURNAGE
MANCHESTER
GREATER MANCHESTER
M19 2JE

Title:
150 EXISTING SITE ELEVATION

Project:
UNILATERAL SW

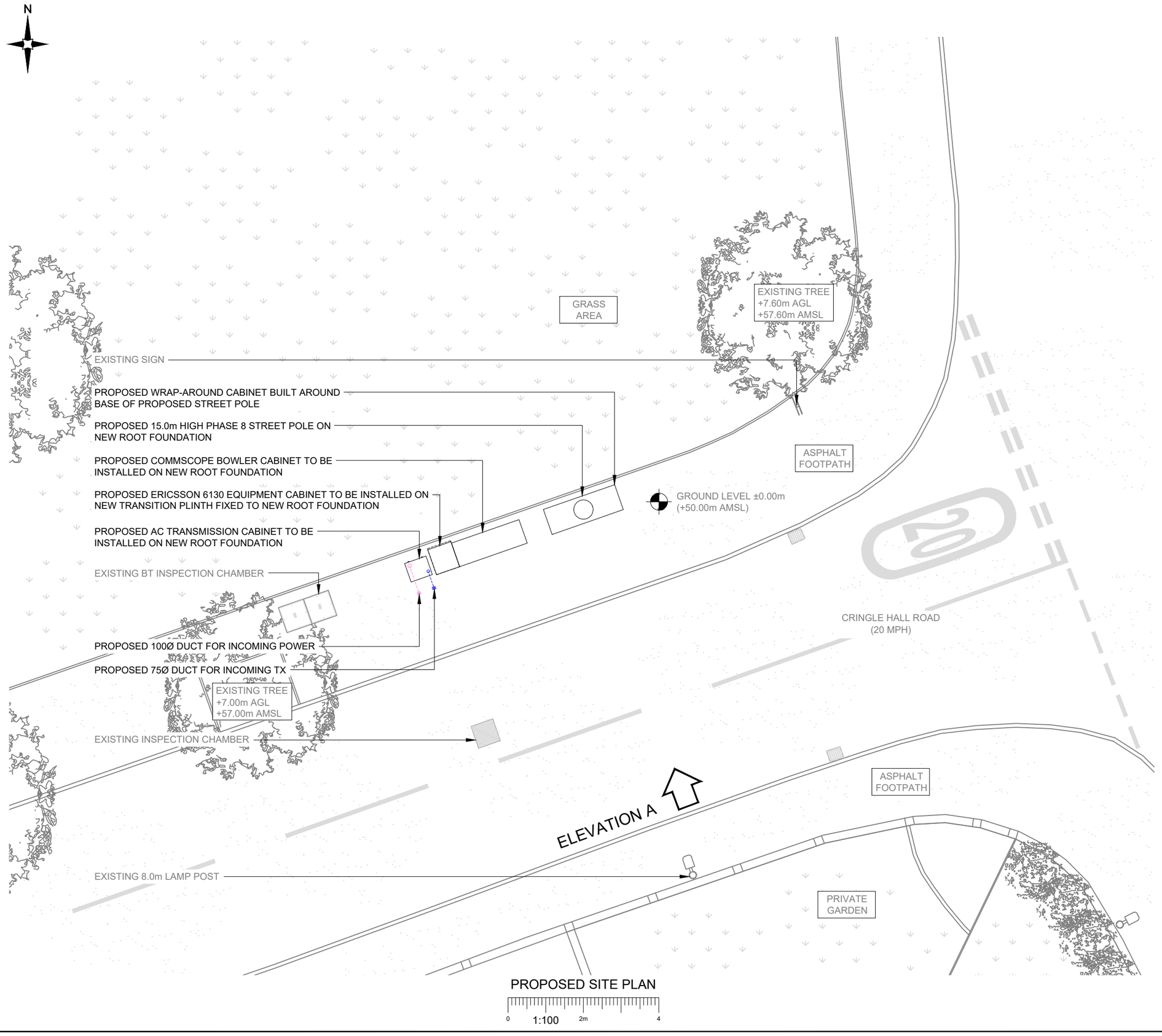
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MBNL/TM/H3G Cell ID:
TBC/TBC/M1267

Drawing No:
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Issue:
A

V 1.8



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3UK Nominal ID:
MAN19864

Address:
CRINGLE HALL ROAD
BURNAGE
MANCHESTER
GREATER MANCHESTER
M19 2JE

Title:
215 PROPOSED SITE PLAN

Project:
UNILATERAL SW

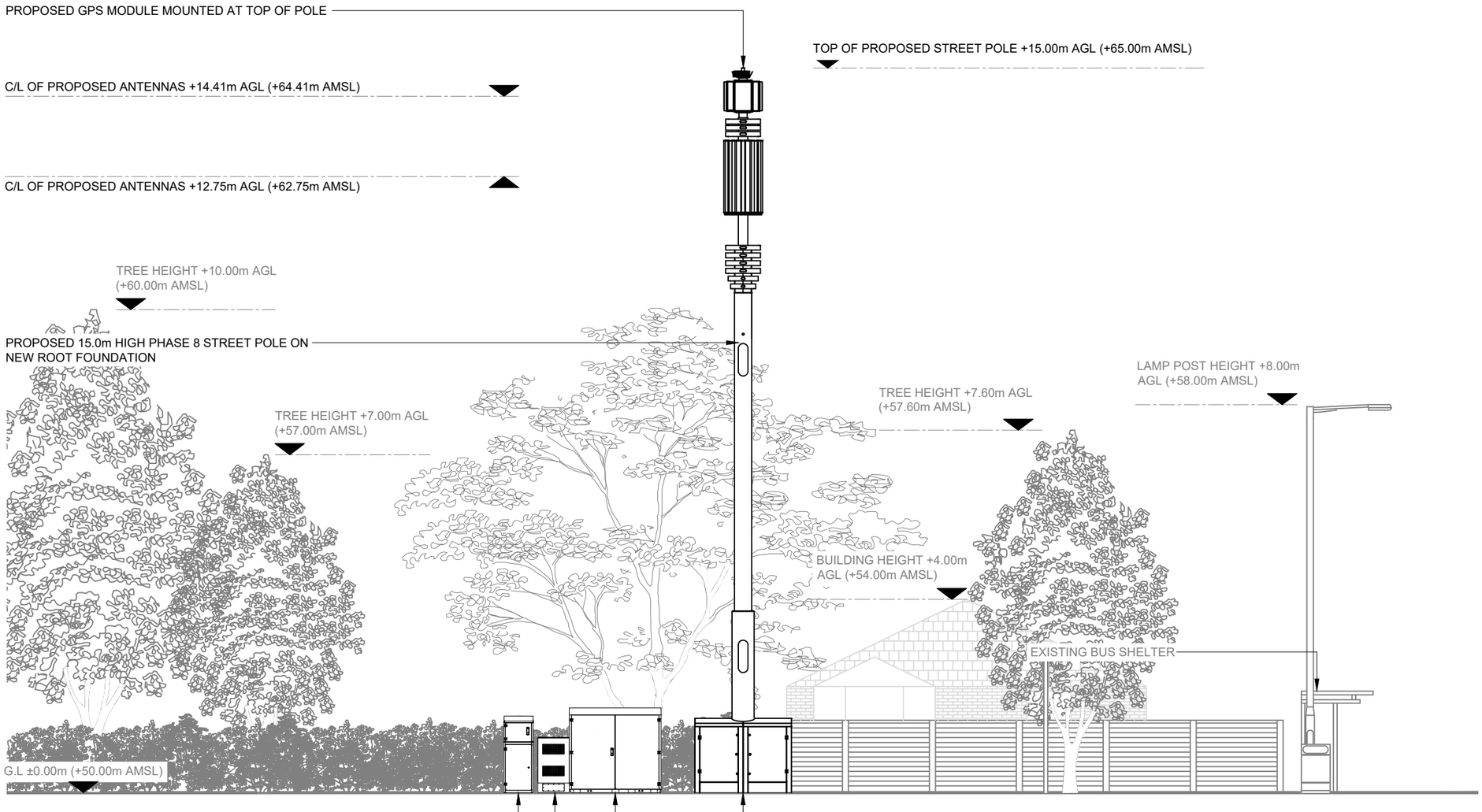
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PLANNING

MBNL/TM/H3G Cell ID:
TBC/TBC/M1267

Drawing No:
MAN19864_TBC_TBC_M1267_GA_REV_A

Issue:
A

V 1.8



PROPOSED SITE ELEVATION A

0 1:100 2m 4

100mm 50mm 10mm

NOTES:

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REV	MODIFICATION	BY	CH	DATE
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t. 44 (0)151 420 4128
www.gbcservices.co.uk

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3UK Nominal ID: MAN19864

Address:
CRINGLE HALL ROAD
BURNAGE
MANCHESTER
GREATER MANCHESTER
M19 2JE

Title: 265 PROPOSED SITE ELEVATION

Project: UNILATERAL SW

Purpose of Issue: PLANNING

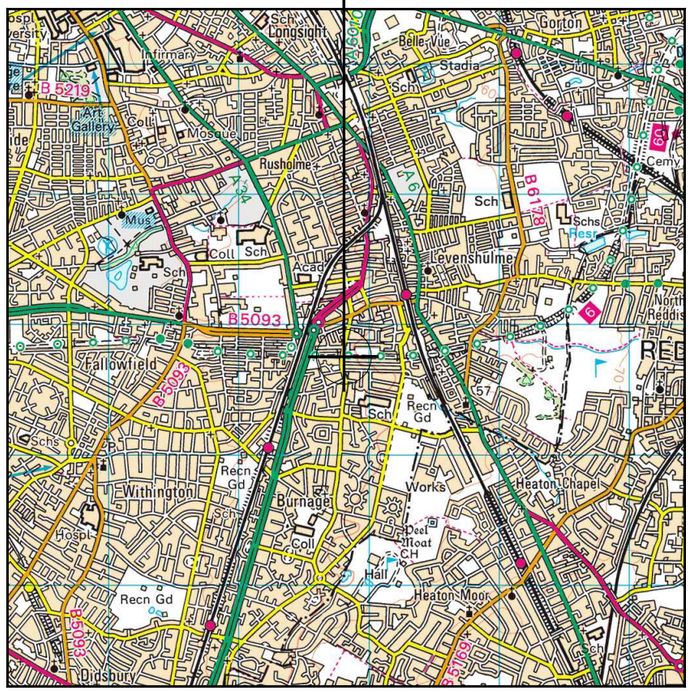
MBNL/TM/H3G Cell ID: TBC/TBC/M1267

Drawing No: MAN19864_TBC_TBC_M1267_GA_REV_A

Issue: A

V 1.8

SITE LOCATION



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SITE AREA PLAN

0 1:50,000 1km 2

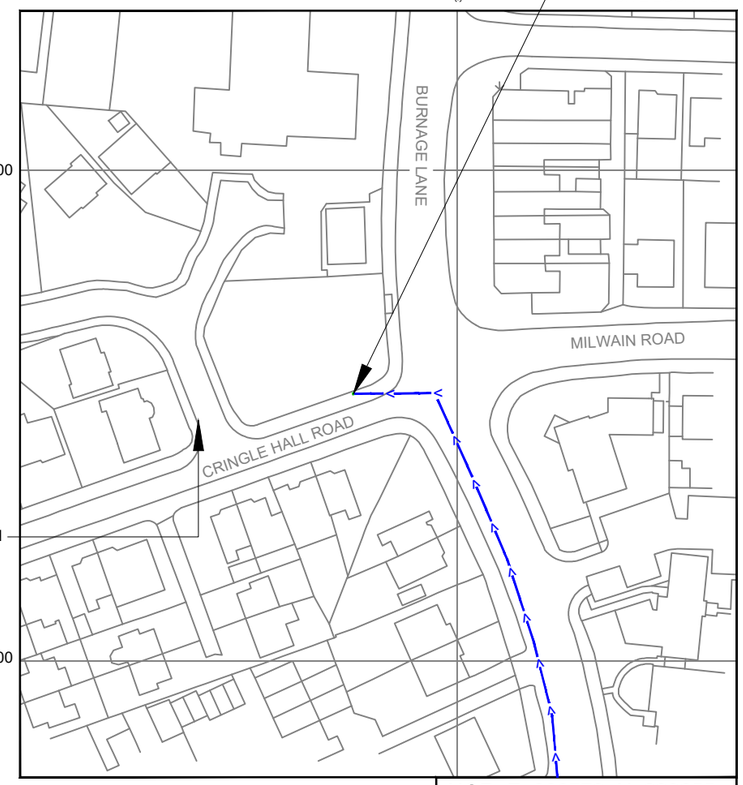


SITE PHOTOGRAPH

N

SITE LOCATION

PARKING LOCATION



NGR E: 386779 N: 393655

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SITE LOCATION PLAN

0 1:1250 25m 50

GOOGLE MAPS QR CODE

GOOGLE MAPS - https://tinyurl.com/3u9jku8k

STREETVIEW - https://tinyurl.com/mhst3tax

NOTES:

1. ALL DIMENSIONS IN MM UNLESS OTHERWISE NOTED.

Access Route To Site:

REV	MODIFICATION	BY	CH	DATE
A	Issued for Planning	RSD	RWB	27.10.21

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Berkshire, England,
RG1 8DJ

Design Consultant & Principal Contractor:

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Tan House Lane, Widnes, Cheshire, WA8 0SL
t. 44 (0)151 420 4128
www.gbcservices.co.uk

Site Name: CRINGLE HALL ROAD

3UK Nominal ID: MAN19864

Address:
CRINGLE HALL ROAD
BURNAGE
MANCHESTER
GREATER MANCHESTER
M19 2JE

Title: 002 SITE LOCATION PLAN

Project: UNILATERAL SW

Purpose of Issue: PLANNING

MBNL/TM/H3G Cell ID: TBC/TBC/M1267

Drawing No: MAN19864_TBC_TBC_M1267_GA_REV_A

Issue: A

100mm
50mm
10mm



HM Treasury

Fixing the foundations:

Creating a more prosperous nation

Cm 9098

July 2015



Fixing the foundations:

Creating a more prosperous nation

Presented to Parliament by
the Chancellor of the Exchequer
by Command of Her Majesty

July 2015

Cm 9098



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Foreword

Productivity is the challenge of our time. It is what makes nations stronger, and families richer. Growth comes either from more employment, or higher productivity. We have been exceptionally successful in recent times in growing employment. We are proud of that. But now in the work we do across government we need to focus on world-beating productivity, to drive the next phase of our growth and raise living standards.

The drivers of productivity are well understood: a dynamic, open enterprising economy supported by long-term public and private investment in infrastructure, skills and science. A nation flourishes when it uses the full skills of all its people in all parts of that nation.

The UK has a long-term productivity problem, which has been made worse by the financial crisis. Like many western democracies the challenge has not been to understand what to do; the challenge has been to be bold enough as a country to take the difficult decisions required to deliver this whole-heartedly. That must now end.

We are determined that Britain does take these decisions. That is the only way to ensure rising living standards and a better quality of life for our citizens. Indeed, our ambition is that Britain becomes the richest of all the major economies by 2030. This document sets out the Conservative government's vision to deliver that.

Every part of government will contribute to this ambition and we and our colleagues will ensure the reforms set out here are delivered with urgency and pace.

Productivity will not be transformed overnight, but the reforms set out here will deliver a step change that can realise both the aspirations of working people, and the ambition that our children's lives will be better than our own. It lays the foundations for a better future.



George Osborne
Chancellor of the Exchequer

July 2015



Sajid Javid
Secretary of State for Business, Innovation and Skills

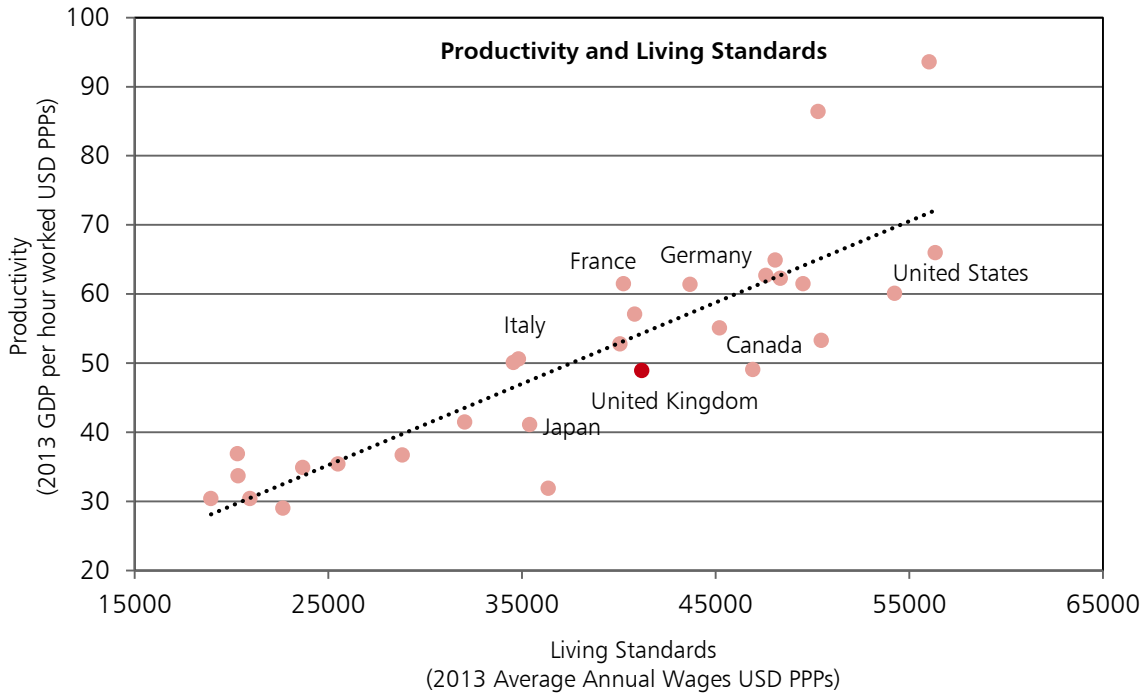
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Executive summary

The importance of productivity

Higher productivity increases household incomes. Productivity is the single most important determinant of average living standards and is tightly linked to the differences in wages across countries. In every member country of the Organisation for Economic Co-operation and Development (OECD) where average wages are above UK levels, productivity is also higher (Chart i).

Chart i: Productivity and living standards



Source: OECD Dataset: Averages annual wages; OECD Dataset: Level of GDP per capita and productivity.

The global economy continues to recover from the most damaging financial crisis in generations. To secure stability and lay the foundations for growth, the government will continue its long term economic plan and eliminate the fiscal deficit.

The UK is set to be the fastest growing G7 economy in both 2014 and 2015, with Gross Domestic Product (GDP) now 4.5% above its pre-crisis peak.[1] Employment is around record levels and has risen by 2 million since the start of the last Parliament, while unemployment is continuing to fall.[2]

Rising employment has been a major source of growth, but over the longer term, productivity is the more essential ingredient. UK productivity has persistently lagged behind other major

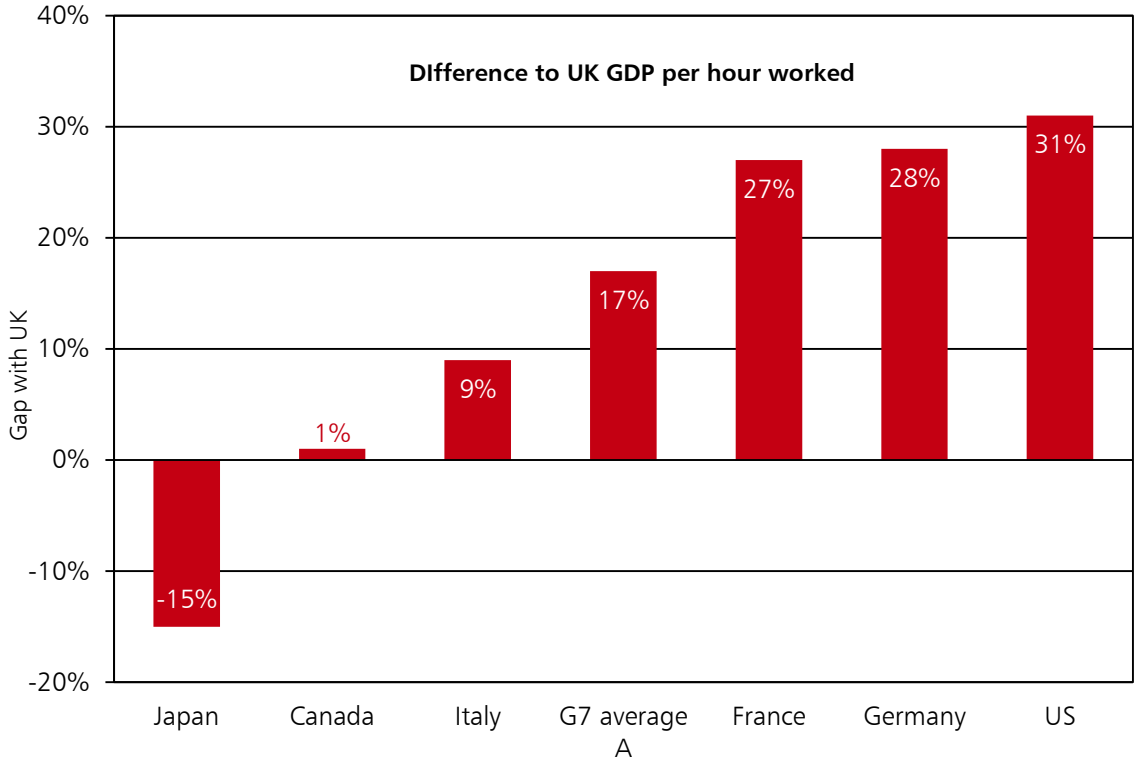
[1] *Quarterly National Accounts*, ONS, June 2015; *Economic Outlook No.97*, OECD, June 2015

[2] *Labour Market Statistics*, ONS, June 2015

economies and although it grew in the decades before the financial crisis, it has stalled sharply in the wake of the crisis.

Raising productivity is an international challenge with an important European dimension. Nevertheless, a large productivity gap exists between the UK and leading advanced economies (Chart ii). The government believes this gap is too large and that narrowing it is a prize worth striving for. Matching the productivity of the US would raise GDP by 31%, equating to around £21,000 per annum for every household in the UK.[3]

Chart ii: The productivity gap: comparisons between the UK and G7



Source: ONS International Comparisons of Productivity – Final Estimates, 2013
A: G7 average excluding the UK

This plan responds to the recent slowdown of productivity growth in the UK and, perhaps more importantly, to the long-standing gap compared to other countries. This is not a quick or easy task, but it is fundamental to securing a sustainable recovery and raising living standards over the long term. Small improvements can have transformative impacts if sustained over long periods. Raising annual trend growth by just 0.1% would mean the UK economy would be £35 billion larger in 2030 – the equivalent of approximately £1,100 extra for every household.[4]

Higher productivity will improve the public finances. The Office for Budget Responsibility (OBR) estimated in 2014 that in a high productivity scenario public sector net debt would fall to 56.7% by 2019-20, while under a low productivity scenario debt would rise to 86.6%.[5] Raising

[3] Note: GDP per household is not a household income metric as GDP also includes Gross Operating Surplus of corporations and other measures of domestic income/production. HMT calculation: 2014 nominal GDP (YBHA) divided by 2014 ONS household estimates; *Quarterly National Accounts*, ONS, June 2015 and *Families and Households*, ONS, January 2015.
[4] HMT calculation: Increasing annual real GDP growth by a theoretical 0.1 percentage point for the next 15 years, relative to a counterfactual where it grows in line with its average since 2000. Forecast for number of households in 2030 taken from DCLG household projections. 2011 prices.
[5] *Economic and Fiscal Outlook*, Office for Budget Responsibility (OBR), December 2014

productivity can also improve the UK's trade position by better enabling UK firms to compete with foreign firms in the global marketplace.

The measures in this plan are based on an assessment of the UK's productivity performance, which is set out in more detail in Annex A. One of the clear challenges that arises in assessing productivity is the difficulty of measuring it accurately in a modern and increasingly technological economy. This is an ongoing challenge and statistical offices globally must rise to it. Professor Sir Charles Bean has therefore agreed to lead an independent review of the quality, delivery and governance of UK economic statistics. The review will build on the established principle of independently produced statistics and make interim recommendations in the autumn with a final report to be published by Budget 2016.

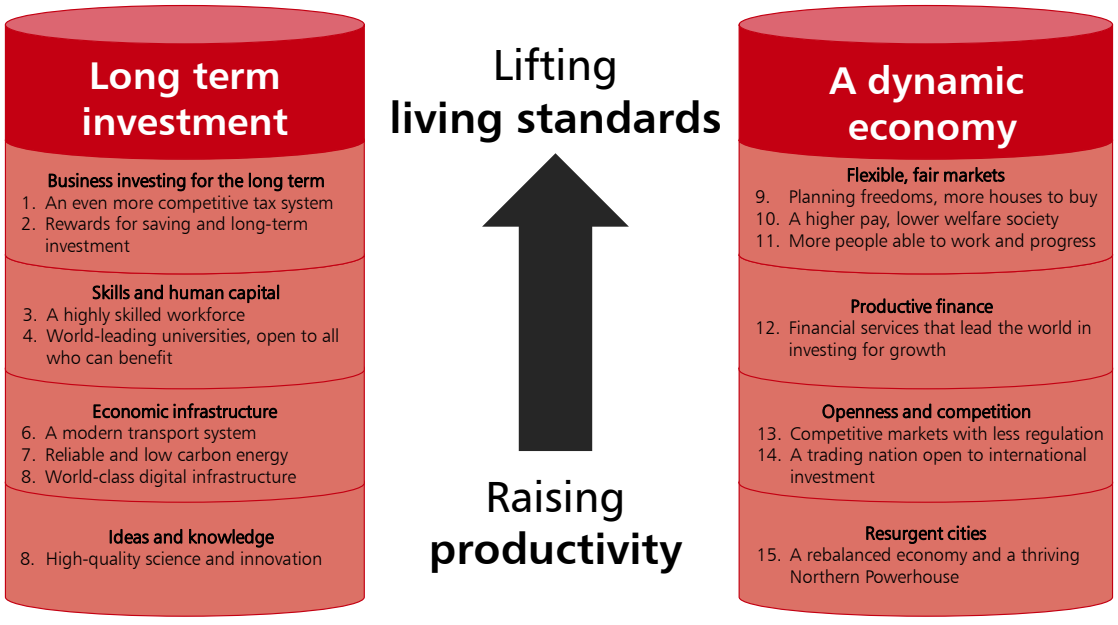
The government's approach to raising productivity

The government's framework for raising productivity is built around two pillars:

- encouraging long-term investment in economic capital, including infrastructure, skills and knowledge
- promoting a dynamic economy that encourages innovation and helps resources flow to their most productive use

These high-level drivers of productivity are based on widely agreed and relatively well-understood academic analysis. The government is now rising to the challenge, and this document sets out a fifteen-point plan for productivity that takes on the hard choices needed for lasting change.

Chart iii: A framework for raising productivity



Source: HM Treasury

Long term investment

1: An even more competitive tax system, bringing business and investment to Britain

High rates of corporation tax distort incentives and stifle business investment. During the last Parliament the main rate of corporation tax was cut from 28% to 20% and the Employment Allowance was introduced to reduce the employer National Insurance contributions (NICs) costs of employers across the country. In this Parliament the government will go further by:

- cutting corporation tax to 19% in 2017 and then again to 18% in 2020, saving businesses £6.6 billion
- reducing income taxes for all with an ambition to increase the personal allowance to £12,500 and increase the higher rate threshold to £50,000 by the end of the Parliament

2: Rewards for saving and long-term investment

For too long the UK has invested too little in its economic future. The government must create the right conditions to support the long-term business investment needed for productivity, and will:

- set the level of the Annual Investment Allowance permanently at £200,000 from January 2016
- provide the certainty and stability businesses need through a new business tax roadmap by April 2016
- remove a distortion which creates an artificial tax bias in favour of mergers and acquisitions, structured to take advantage of the relief
- build on the stronger incentives for individuals to save introduced in the last Parliament – significant increases in the ISA allowance, the new Personal Savings Allowance, and greater flexibility in accessing pensions – by consulting on the case for reforming pensions tax relief to simplify the system and strengthen incentives to save for the long term
- endorse proposals from some of the country's largest investors to support companies investing for long-term growth and challenge those that are compromising long-term competitiveness and productivity
- engage with some of the country's most senior business leaders, led by Sir Charlie Mayfield, as they develop their proposals for improving business productivity

3: A highly skilled workforce, with employers in the driving seat

The UK's skills weaknesses – and failure to grow a serious system of respected employer-led professional and technical qualifications – are of such long standing, and such intractability, that only the most radical action can address them. The government will:

- target 'coasting' schools for improvement as well as outright school failure, improve teaching quality, and make schools funding fairer
- respond to businesses' calls to improve work-ready skills. Reforms are increasing the rigour of GCSEs and A levels, including in maths and science

- introduce a new compulsory apprenticeship levy requiring large employers to invest in their own future so that the 3 million apprenticeships delivered during this Parliament will be well funded, high quality, and meet employers' real needs
- radically simplify and streamline further education qualifications and move away from funding on a per qualification basis; invite local areas to participate in the reshaping and commissioning of local provision; and create a network of prestigious Institutes of Technology, focussed on the higher level skills employers demand

4: World-leading universities, open to all who can benefit

Our excellent university sector cannot be kept competitive, and open to all who can benefit, unless we make hard choices about funding. The government will:

- remove the student numbers cap so that anyone with the right qualifications can study at university
- ensure the long term sustainability of investment in universities by replacing maintenance grants with loans for new students from 2016-17, while providing more cash in hand in real terms than has ever been provided to help students from lower to middle income backgrounds meet the cost of living while studying
- introduce a new Teaching Excellence Framework to sharpen incentives for providing an outstanding education to students
- allow institutions offering high teaching quality to increase tuition fees with inflation, to ensure that the universities sector remains well funded to compete internationally
- open the higher education market to more new entrants to stimulate competition and innovation, increase choice for students, and deliver better value for money

5: A modern transport system, with a secure future

For decades, the UK has not invested well enough in the transport infrastructure that is the lifeblood of business, particularly roads; there have been too many rail failures; and the costs to the economy of not addressing airport capacity constraints are estimated at £30-45 billion.[6] The government will:

- create a new Roads Fund by 2020-21, funded directly by the revenues from Vehicle Excise Duty, to ensure continued high and stable investment in the strategic road network for generations to come
- produce an ambitious second Roads Investment Strategy before the end of this Parliament, for the period 2020-25, based on this new Roads Fund
- ensure Network Rail can deliver effectively and safely, by appointing Sir Peter Hendy as Chairman to develop a plan to get the rail investment programme back onto a sustainable footing
- ask Sir Peter Hendy to continue the work within Network Rail to devolve further to route managers closer to the front line, so that the railways are more focussed on delivering what passengers need

[6] *Airports Commission Interim Report*, Airports Commission, December 2013

- change the way it provides public money through the rail industry, so that Network Rail focusses firmly on the needs of train operators, and, through them, passengers
- establish a dedicated body with a new approach to station redevelopment and commercial land sales on the rail network
- appoint Nicola Shaw, Chief Executive of High Speed 1, to advise on the long term future shape and financing of Network Rail, working closely with Sir Peter Hendy
- take a decision on airport capacity in the south east by the end of the year
- invest £100 billion in all infrastructure over this Parliament, giving long-term certainty and increased funding to the most productive areas of infrastructure spend

6: Reliable and low-carbon energy, at a price we can afford

Energy underpins the operation of a successful and productive economy. We need a better plan to meet the triple challenge of security of supply, affordability and sustainability. To deliver this, the government will:

- ensure the UK attracts the necessary investment to guarantee secure energy supplies, including through the development of shale gas, North Sea oil and gas production, and new nuclear power stations
- continue the long-term decarbonisation of the UK's energy sector through a framework that supports cost effective low carbon investment
- take action to reduce bills for businesses and consumers, by strengthening competition in the market
- conduct a review of business energy tax policy to improve and simplify the landscape

7: World-class digital infrastructure in every part of the UK

Our digital infrastructure is improving fast, but there are still too many businesses hampered by slow connections, and households who cannot play their full part in the digital economy. The government will:

- ensure superfast broadband (at least 24Mbps) is available to 95% of UK households and businesses by 2017; the government's superfast broadband programme is passing an additional 40,000 premises every week
- support the market to deliver near universal 4G and ultrafast (at least 100Mbps) broadband coverage
- make it easier for the market to roll out the fixed and mobile infrastructure the UK needs, including through proposals to reform planning rules on taller mobile masts

8: High-quality science and innovation, spreading fast

Our science base is a vital national asset, but to stand still in science and innovation is to be left behind; and we need new ideas to spread and be used as widely as possible. The government will:

- deliver on the science capital commitment, investing £6.9 billion in the UK's research infrastructure up to 2021
- ensure the UK's excellent science has a focus on those areas with greatest potential, from genetics to quantum technology, and has asked Sir Paul Nurse to lead an independent review on how best to make these strategic choices
- look for opportunities to develop the UK's network of Catapult centres for commercialising technology
- support universities in collaborating with industry and commercialising research, responding to Professor Dame Ann Dowling's review

Dynamic Economy

9: Planning freedoms and more houses to buy

The UK has been incapable of building enough homes to keep up with growing demand. This harms productivity and restricts labour market flexibility, and it frustrates the ambitions of thousands of people who would like to own their own home. The government will:

- introduce a new zonal system which will effectively give automatic permission on suitable brownfield sites
- take tougher action to ensure that local authorities are using their powers to get local plans in place and make homes available for local people, intervening to arrange for local plans to be written where necessary
- bring forward proposals for stronger, fairer compulsory purchase powers, and devolution of major new planning powers to the Mayors of London and Manchester
- extend the Right to Buy to housing association tenants, and deliver 200,000 Starter Homes for first time buyers
- restrict tax relief to ensure all individual landlords get the same level of tax relief for their finance costs

10: A higher pay, lower welfare society

Despite progress during the last Parliament, the welfare bill remains stubbornly and disproportionately high. The welfare system should ensure that people are incentivised and helped to find work which is fairly paid, and that the taxpayer does not subsidise low pay or foot the bill for an unfair system where too many people remain on benefits. The government will:

- further reduce the household benefit cap alongside a four year freeze in working-age benefits (except disability benefits and statutory payments)
- increase the personal allowance to £11,000 in 2016-17, ensuring that 29 million people will keep more of their hard-earned income next year
- introduce a National Living Wage (NLW) for workers aged 25 and over, to reach £9 by 2020
- reform the tax credits system (and its successor, Universal Credit) to focus it on those on lower incomes and end unlimited support for large families

11: More people with a chance to work and progress

There are still too many people for whom there are unfair or distorting barriers to work – including women and disabled people, whose high levels of skill are too often underused. The government has set out stretching ambitions to increase employment and halve the disability employment gap: the government will therefore:

- double the free entitlement to childcare, to 30 hours a week for working parents of three and four year olds
- expect parents claiming Universal Credit to do more to look for work when their youngest child turns 3, and to prepare for work when their youngest child turns 2
- reform Employment and Support Allowance to ensure the right incentives and support are in place for those capable of taking steps back to work, by ensuring that new claimants who are placed in the Work Related Activity Group receive the same rate as those claiming Jobseeker's Allowance
- introduce a new Youth Obligation for 18 to 21 year olds on Universal Credit

12: Financial services that lead the world in investing for growth

Our financial services sector has suffered since the crisis, and we can do more to promote the most productive forms of investment. The government will:

- highlight the importance of ensuring the supply of finance to support productive investment in setting the Financial Policy Committee's (FPC) 2015 remit
- ensure the Prudential Regulation Authority (PRA) and Financial Conduct Authority (FCA) create a joint New Bank Unit to promote competition
- champion the development of new and innovative technologies and ideas, including through the appointment of a Special Envoy for Fintech
- implement a long term plan for the taxation of banks, giving stability and sustainability and securing competitiveness

13: Open and competitive markets with the minimum of regulation

The UK's open and competitive market economy leads the world, but there is no room for complacency in pushing for ever greater consumer power, nor in fighting stifling regulation. The government will:

- cut a further £10 billion of red tape
- introduce clear new principles for consumer switching, and legislate to support quick and easy switching in communications markets
- champion enterprise, stimulating finance for Small and Medium-sized Enterprises (SMEs)
- publish a Digital Transformation Plan, with actions to support the adoption of digital technologies across the economy

14: A trading nation, open to international investment

The government's focus on exports has started to make a difference; but we still trail many of our international competitors, and the ambitious £1 trillion target will not be met without a step change. The government will:

- build stronger trading links with emerging markets, especially China, India and Brazil
- mobilise the whole of government behind exporting, working alongside a more effective UK Trade and Investment (UKTI) and better export finance
- help deliver a Europe that is more dynamic and outward focussed as part of our renegotiation, by accelerating the integration of the single market, completing trade agreements, and improving the quality of regulation

15: Resurgent cities, a rebalanced economy and a thriving Northern Powerhouse

Our economy cannot grow as it should while it is so skewed towards London and the south east. We have started to build the Northern Powerhouse, through: committing £13 billion of investment to transport in the north of England over this Parliament; backing major new science, and technology and culture projects; and agreeing to devolve significant powers over transport, housing, health, planning and policing to an elected mayor for Greater Manchester. The government is also taking steps to enable the Midlands Engine for Growth to reach its full potential. But there is far more to be done if we want resurgent cities and a rebalanced economy. The government will:

- devolve further powers to Greater Manchester and London, including consulting on Sunday trading
- devolve further planning powers to the Mayors of Greater Manchester and London
- work towards devolution deals with the Sheffield City Region, Liverpool City Region, and Leeds, West Yorkshire and partner authorities
- put Transport for the North on a statutory footing and give it a budget, clear leadership and a focussed remit, including working to introduce Oyster-style integrated and smart ticketing across the North
- ensure that rural areas can also contribute to, and benefit from, productivity growth

This plan commits the government to concerted action, covering every major government department. It will also be accompanied by a set of clear actions on public sector productivity, set out in Chapter 16. It is an agenda for the UK's overall domestic policy for the course of this Parliament, and it will be tracked and driven forward by the Cabinet Committee on Economic Affairs, under the leadership of the Chancellor of the Exchequer.

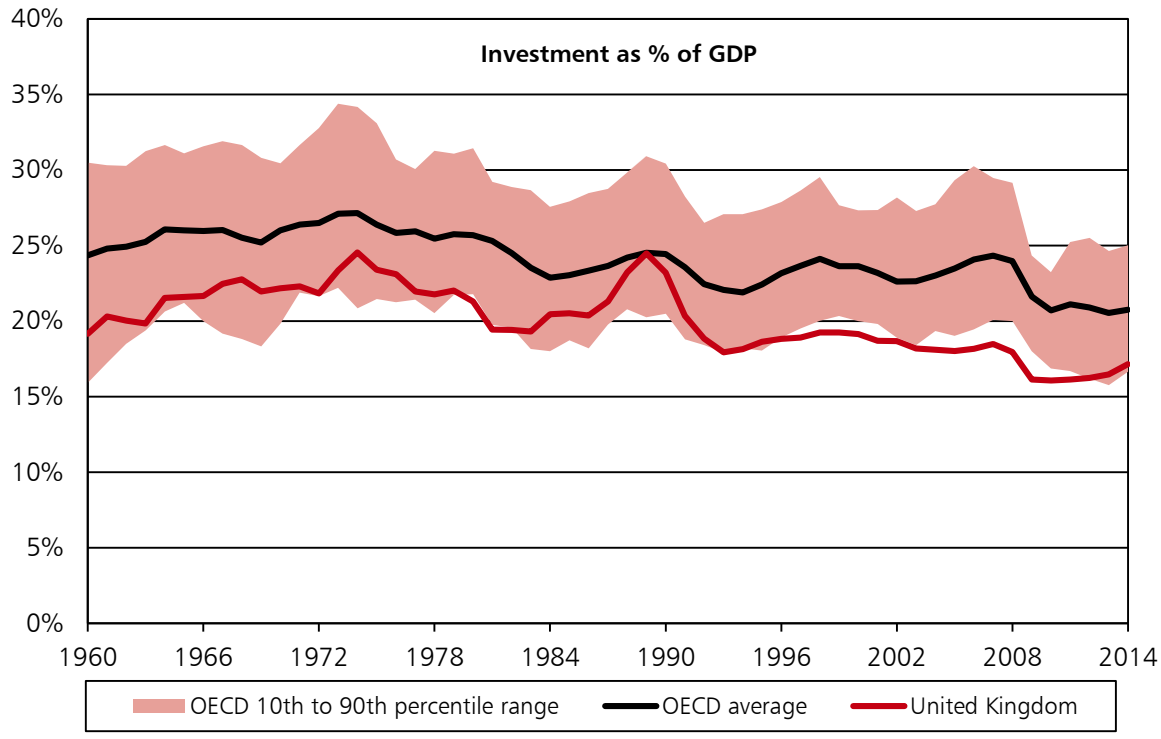
A Section A: Long-term investment

Investment is an essential part of raising productivity. In today's economy that is not simply a matter of increasing the stock of machines, equipment and essential physical infrastructure but also, crucially, the development of human and intellectual capital.

The UK has long had a mixed record on investment, in both public and private sectors.[1] Despite strengths in higher level skills, problems remain at basic and intermediate levels. Total spend on Research and Development (R&D) has been under the OECD average but the UK has world-leading science, with high levels of investment in knowledge assets ('intangibles'). [2]

Expenditure on physical investment, which captures many forms of critical infrastructure, has been persistently low. As a share of GDP, investment in the UK has ranked in the lowest 25% of OECD countries for 48 of the last 55 years, and the lowest 10% for 16 of the last 21 years[3] (Chart iv).

Chart iv: UK investment since 1960



Source: OECD Dataset: Quarterly National Accounts.

This section of the plan sets out how the government will create the conditions for higher private investment, improve the targeting of public investment to transform vital infrastructure and skills, and promote long-term decision making among companies and investors.

[1] *Investing for prosperity: skills, infrastructure and innovation*. LSE Growth Commission (2012)

[2] Individual references in chapters

[3] OECD stats database: *Quarterly National Accounts*

The government made good progress on improving UK infrastructure in the last Parliament. The first-ever National Infrastructure Plan (NIP) was published, creating a coherent vision for UK economic infrastructure, and providing transparency and clarity on plans to finance and deliver critical projects. Average annual infrastructure investment (public and private) increased by 15%[4] in real terms on the previous Parliament. The government will invest £100 billion in infrastructure over this Parliament, channelled towards projects that make the most difference to improving the UK's productivity.

The government will publish a new long-term National Infrastructure Plan for the key economic infrastructure sectors – transport, energy, flood defences, water, waste, communications and science. This will be supported by annual updates on progress with delivery. The government will also publish a dedicated National Infrastructure Plan for Skills in the summer, to provide analysis of current capability and future need and ensure the UK has the right skills base to deliver and maintain world-class infrastructure. The NIP will continue to be underpinned by the Infrastructure Pipeline, which will be published on a regular basis, starting with an update this summer.

[4] *National Infrastructure Plan*, HM Treasury, December 2014

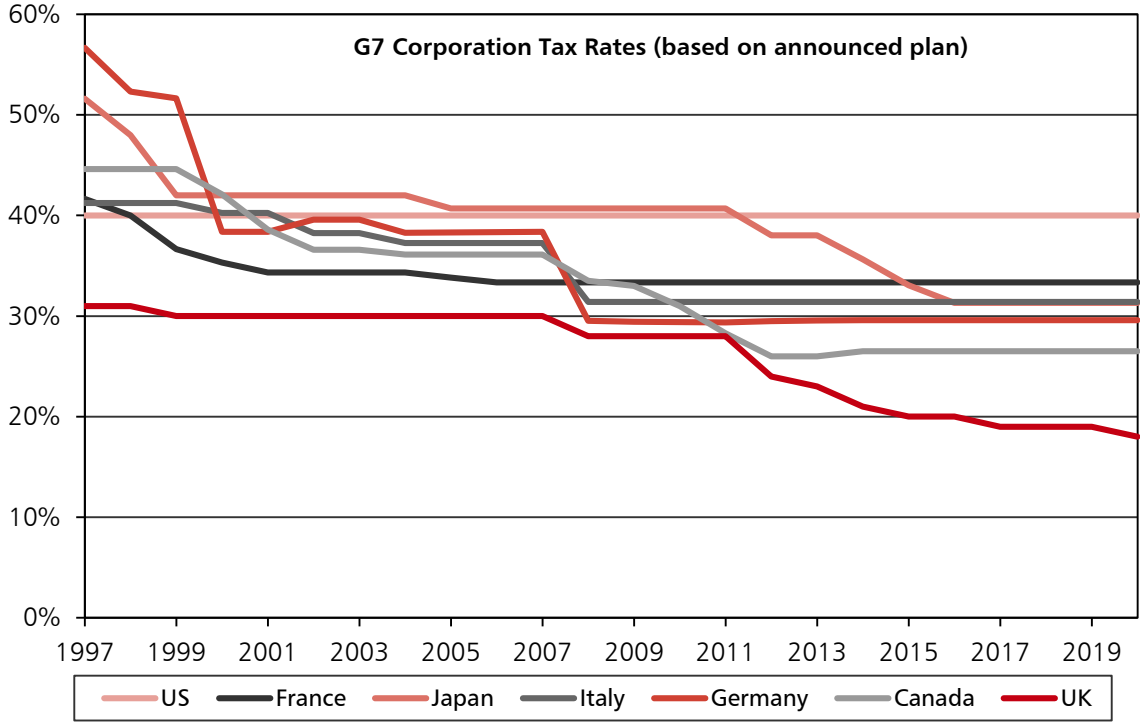
1 An even more competitive tax system, bringing business to Britain

1.1 The tax system can support productivity by providing incentives, stability and certainty for long-term investment and innovation, avoiding distorting economic choices, and minimising the administrative burden of paying taxes.

1.2 Since 2010 the government has cut the main rate of corporation tax from 28% to 20%, cut the small profits rate to 20%, and merged the two rates to simplify the system. Overall the cuts delivered in the previous Parliament will save companies £10 billion a year.[1]

1.3 In this Parliament, the government will go further, by cutting corporation tax to 19% in 2017 and then again to 18% in 2020. These new cuts will save businesses a further £6.6 billion by 2021, benefitting 1.1 million businesses. Reducing corporation tax increases the return a company receives on its investment, so incentivises companies to invest and grow. That investment is vital to long-run productivity growth. As a result of the Summer Budget 2015 announcement, the UK will have the lowest rate of corporation tax in the G20 and by far the lowest in the G7, making the country even more attractive to inward investors.

Chart 1.A: Corporation Tax rates in the G7



Source: Bloomberg, KPMG, HM Treasury

1.4 The government will continue making tax easier and simpler by putting the Office of Tax Simplification (OTS) on a permanent footing and increasing its capacity and remit. By 2020

[1] HMRC analysis

digital accounts will dramatically cut the cost of paying tax for business. The terms of reference for the next OTS reports on the closer alignment of income tax and NICs and the taxation of small companies will be published shortly.

1.5 The government believes in lower taxes. The cornerstone of this commitment is to introduce into legislation a tax lock to rule out increases in the main rates of income tax, National Insurance, and VAT, over the course of this Parliament. The government also has an ambition to increase the personal allowance to £12,500 and increase the higher rate threshold to £50,000 by the end of the Parliament.

2 Rewards for savings and long-term investment

Supporting individuals to save

2.1 Saving by individuals, notably in pension funds, is a key source of finance for investment. In 2011, the value of assets held in UK pensions was over £2 trillion (135% of GDP).[1] Pension schemes invest in a variety of asset classes including equities, government bonds, corporate bonds, property and infrastructure. A further £470 billion is held in ISAs.[2]

2.2 Over the course of the last Parliament, the government made several changes to pensions and savings policy to encourage saving. Employees now have the opportunity to contribute to a workplace pension through automatic enrolment, which by 2020 will generate £11 billion a year more in workplace pension saving. The government has also given individuals greater freedom with their pension savings when they come to retire, which has led to greater engagement with pension savings.[3] At the Summer Budget 2015, the government launched a consultation on the case for reforming pensions tax relief in order to simplify the system and strengthen the incentive for individuals to save for the long term. These steps will support a culture of saving and financial resilience, and ensure that pension funds continue to provide a source of finance for investment.

2.3 The government has also significantly strengthened incentives to save more generally, both by cutting tax and by giving individuals more flexibility. A new Personal Savings Allowance will be introduced in 2016, exempting up to £1,000 of interest from tax. £15,240 can be saved into an ISA this year, with no distinction between cash and stocks and shares, up from a 2010-11 limit of £10,200 (of which only half could be cash). The range of eligible investments has been expanded to support business growth and financial innovation.

A tax system that supports productive investment

2.4 Tax policy influences the returns that firms can make from investment and innovation, and is a critical factor in the willingness of foreign firms to invest and locate in the UK. HM Revenue and Customs (HMRC) analysis shows that £1 of tax relieved by R&D tax credits stimulates between £1.53 and £2.35 of additional R&D investment.[4]

2.5 The government is taking steps to provide certainty to businesses wanting to plan their medium and longer term investment. From January next year the government will increase the permanent level of the Annual Investment Allowance to £200,000, its highest ever permanent level. The government will complete a major review on the future of business rates by the end of 2015.

2.6 By April 2016, the government will publish a Business Tax Roadmap which will set out the government's plans for business taxes across the rest of the Parliament. In order to ensure broader stability, the government is also legislating to lock the main rates of income tax, National Insurance Contributions and VAT.

[1] *Pension Trends*, Office for National Statistics, 2013. Includes both accumulation and decumulation.

[2] *Individual Savings Account (ISA) statistics*, HMRC, April 2015. Data for tax year 13/14.

[3] *28% of workers more likely to save into a pension following Budget, finds NAPF survey*, National Association of Pension Funds, April 2014

[4] *Evaluation of Research & Development Tax Credit*, Fowkes et al., 2015

2.7 Tax-advantaged venture capital schemes provide an important incentive for individuals to invest in small and growing UK companies. The government is making changes to ensure that the schemes continue to provide significant and well-targeted support. This includes higher investment limits for knowledge-intensive companies, recognising the importance of supporting innovation.

2.8 To ensure commercial factors drive the structure and price of mergers and acquisitions, the government will stop companies obtaining a deduction from their taxable profits for the acquisition cost of assets linked to the business' reputation and customer relationships. This is consistent with the rules in other major economies, and will remove a distortion in the market which is artificially altering the way companies choose to expand.

Long-term decision making by companies and investors

2.9 For too long, the UK has invested too little in its economic future. This plan focusses on the role that the government needs to play in creating the right conditions for investment. But for companies to thrive and national productivity to grow, firms must be prepared to invest in building the skills of their workforce, developing new and improved products and services, and in new technology. These are all things that require businesses to take a long-term view.

2.10 Over many years there has been a debate around this issue in the UK. For instance:

- equity markets can focus disproportionately on short-term results. Work by the Bank of England, for instance, suggests that investments yielding returns in the longer term are disproportionately undervalued relative to returns in the near term.[5] This can have damaging consequences for long-term growth
- the nature of the 'investment chain', which connects fund managers to those beneficiaries whose money they are managing, can create inefficiencies – for instance through the nature of benchmarks, imperfect incentive structures and an excessive focus on quarterly performance reporting
- some, such as Professor John Kay in a report commissioned by the previous government, argue that an excessive focus on restructuring, financial engineering and mergers and acquisitions in the UK can be a damaging distraction from investment in fundamental productive capacity[6]
- others, like Andrew Smithers and William Lazonick,[7] argue that the structure of executive incentives can put too much emphasis on short-term performance measures and encourage share buy-backs
- elevated levels of cash on company balance sheets and sometimes high hurdle rates for investment have been seen as evidence of a failure by companies to identify or take advantage of good potential investment opportunities[8]

2.11 This debate is not, however, straightforward or altogether conclusive. Many of the forces seen by critics as potentially driving short termism in the UK, such as a rigorous focus by institutional investors on corporate performance, and a culture which exposes underperforming firms to the threat of takeover, are argued by others to be as likely to promote productivity as to

[5] *The Short Long*, a speech by Andrew G Haldane and Richard Davies, Bank of England, May 2011

[6] *The Kay Review of Equity Markets and Long-Term Decision Making*, Final Report, Department for Business, Innovation and Skills, July 2012

[7] *The Road to Recovery*, Andrew Smithers, September 2013; *Stock buybacks: From retain-and reinvest to downsize-and-distribute*, William Lazonick, Brookings, April 2015

[8] *Bad information is bad for the economy*, Andrew Smithers, Financial Times, May 2015; *Private non-financial corporations cash research,* AGFE, in partnership with Experian, for BIS, March 2015

damage it. Moreover the US, the nature of whose corporate and capital market environment has much in common with the UK, nevertheless enjoys substantially higher levels of innovation and capital investment.

2.12 What is absolutely clear, however, is that while the government can do much to create a climate which is conducive to investment, innovation and productivity growth, the role of firms (including non-executive directors) and their investors is fundamental if higher levels of productivity are to be achieved.

2.13 Accordingly, alongside this productivity plan, the government strongly welcomes two developments also announced today:

- a number of the country's largest institutional investors have written to the government with their proposals to support companies investing for long-term growth and challenge those that are compromising long-term competitiveness and productivity
- some of the country's most senior business leaders, convened by Sir Charlie Mayfield, Chairman of the John Lewis Partnership, have written to the government making the case for taking forward a business-led action group for productivity. The work will be practical and grounded, driving direct action to enhance productivity in different sectors and workplaces across the UK. The group has offered to report to the Chancellor and the Secretary of State for Business by the end of the year

3 A highly skilled workforce, with employers in the driving seat

3.1 Over the last century, productivity growth has gone hand in hand with rising human capital, as more people have become educated, and to a higher level. However, the UK suffers from several weaknesses in its skills base that have contributed to its longstanding productivity gap with France, Germany and the US. Results from the OECD show that England and Northern Ireland are in the bottom four countries for literacy and numeracy skills among 16-24 year olds.[1] The UK also performs poorly on intermediate professional and technical skills, and is forecast to fall to 28th out of 33 OECD countries for intermediate skills by 2020.[2] It is imperative that the UK addresses these shortfalls if productivity is to improve.

Schools reform

3.2 The government wants schools to offer a broad and rigorous academic curriculum, building knowledge, skills, character and resilience. The government's goal is for all pupils starting year 7 in September 2015 to study the English Baccalaureate.[3] The government is introducing new, more rigorous GCSE and A-levels in maths and science, and will focus on increasing the take-up of STEM subject[4] A-levels for girls in particular. Young people without good grades in maths and English at GCSE will continue to study the subjects until the age of 18.

3.3 Teaching quality is the most significant factor driving school outcomes, and the government will support England's teaching workforce to be world class, including a new initial teacher training curriculum. Record levels of top graduates are now joining the profession and nearly three quarters of graduates starting teacher training now have a 2:1 level university degree or higher.[5] The government has introduced greater flexibility for schools to pay the best teachers more, and is supporting the establishment of a new independent College of Teaching. In order to ensure that England has the highest STEM teaching quality, the government will train an additional 17,500 teachers in STEM subjects. The government will also encourage greater use of evidence on 'what works' - there remains significant scope for schools to make better use of evidence, such as from the Education Endowment Foundation.

3.4 The government will also improve the quality of schools in all areas of the country. More children than ever are now in a good or outstanding school. There are now more than 4,700 academies, 254 new free schools, 30 University Technical Colleges (UTCs) and 37 studio schools.[6] The government will open a further 500 free schools and ensure there is a UTC within reach of every city. The government will turn inadequate schools into academies and improve their leadership, as well as targeting coasting schools for improvement. The government will make schools funding fairer and focus efforts to support school improvement in

[1] *Adult Skills Survey*, Organisation for Economic Co-operation and Development, 2013. Results are not available for Scotland or Wales.
[2] *UK Skill Levels and International Competitiveness,* 2013 , Derek L Bosworth, August 2014
[3] English, mathematics, science, one modern foreign language and either history or geography
[4] Science, Technology, Engineering, Mathematics
[5] *Initial Teacher Training: trainee number census - 2014 to 2015,* Department for Education
[6] Department for Education open academies and free schools tracker

underperforming areas, including coastal areas, encouraging the best academy chains to expand and bringing new sponsors where they are needed.

Apprenticeships

3.5 Apprenticeships are a key part of some of the most successful skills systems across the world. In many countries they offer young people in particular a high quality training route where they develop skills tailored to a particular sector or industry and earn while they learn.

3.6 The critical need for high numbers of new technical and professional skilled workers to enter the workforce in the coming years presents a strong case for a high quality apprenticeship system in the UK: analysis indicates that by 2022 there will be an additional 3.6 million jobs in medium-skilled occupations, including skilled trades and health care professions.[7]

3.7 **The government has therefore committed to significantly increasing the quantity and quality of apprenticeships in England to 3 million starts this Parliament**, putting control of funding in the hands of employers.

3.8 In the last Parliament there were over 2.3 million apprenticeships starts in England.[8] Increasing this to 3 million new starts over this Parliament will mean an increase of over 30% on the achievement of the last five years. The government is taking a number of steps to deliver this:

- employer-routed funding reforms, such as the digital apprenticeships voucher, are putting control of funding directly into hands of employers
- apprenticeships will be given equal legal treatment to degrees, to ensure that apprentices and employers can be given confidence in the brand
- the government will abolish employer NICs for almost all apprentices under the age of 25 from April 2016
- the government will set apprenticeship targets for public sector bodies

3.9 However, a step change in the scale of the apprenticeship programme also needs a step change in funding. Achieving this change will require a reversal in the trend of employer underinvestment in training, which has seen a rapid decline in the amount and quality of training undertaken by employees over the last 20 years (Chart 3.A). This decline is in part due to employer concerns that if they invest in training their employees, competing firms will free-ride on their investment. This needs to change.

3.10 A new approach is needed which puts employers at the heart of paying for and choosing apprenticeship training. In recognition of this, **the government will introduce a levy on large UK employers to fund the new apprenticeships**. Levies to fund training are already in place in Germany, France, Denmark and over 50 other countries, often supporting high quality apprenticeship systems.[9] As Professor Alison Wolf has set out in a recent report, it is now time for the UK to do this as well.[10]

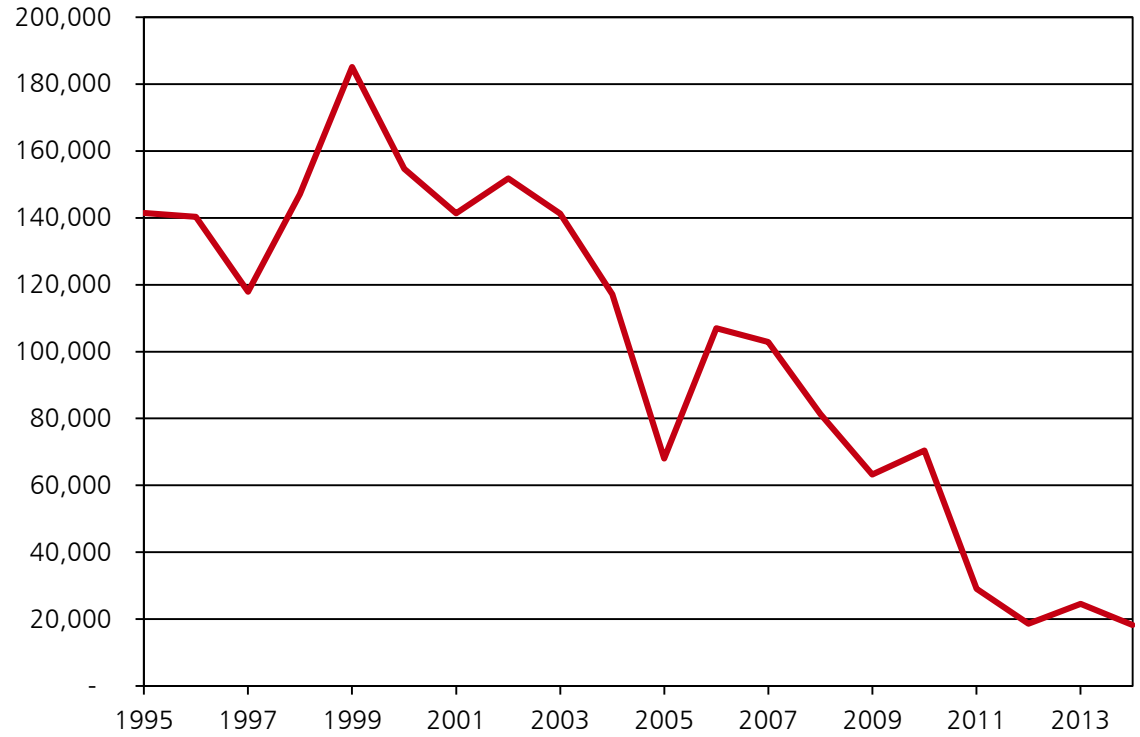
[7] *Winning the global race? Jobs, skills and the importance of vocational education*, J Clifton et al., June 2014

[8] Data from Individualised Learner Record

[9] *Subsidies and Levies as Policy Instruments to Encourage Employer-Provided Training*, OECD Education Working Papers, No. 80, N Müller and F Behringer, June 2012; *A review of national training funds*, Richard Johanson, November 2009

[10] *Fixing a Broken Training System: The case for an apprenticeship levy*, Professor Alison Wolf, July 2015

Chart 3.A: Employees working fewer hours because of training [a]



Source: Office for National Statistics, Labour Force Survey

[a] Number of people in employment whose actual hours worked in reference week was less than usual hours because of training course away from workplace

3.11 The levy will apply to large employers and will support all post-16 apprenticeships. In England, any firm will be able get back more than it puts in by training sufficient apprentices. The government will put control of the funding in the hands of employers via the digital voucher scheme to ensure that it delivers the training they need. Crucially, this will enable an increase in the quality of apprenticeships at the same time as an increase in quantity.

3.12 Formal engagement with business on the implementation of the levy will take place; this will also consider the interaction with existing sector levy boards. Further details will be set out at the Spending Review.

Professional and technical education

3.13 The government's ambition is for a professional and technical education system that provides individuals with clear, high-quality routes to employment, and that supports the government's overall fiscal and economic objectives. To achieve this, the government will simplify and streamline the number of qualifications so that individuals have a clear set of routes which allow for progression to high level skills, rather than thousands of qualifications.

3.14 Professional and technical education provision, of which the majority is currently at level 2 and below, needs to be refocussed to deliver the higher level skills that employers need.[11] Strong institutions are needed to support this ambition. The creation of National Colleges has been announced to provide high-level sector-specific training. The government will go further and invite some colleges to become prestigious Institutes of Technology to deliver high-standard provision at levels 3, 4 and 5. Building on international best practice, Institutes of Technology

[11] For breakdown of learner participation by level, see *Further Education and Skills Statistical First Release*, 2015

will be sponsored by employers, registered with professional bodies and aligned with apprenticeship standards. The government will empower National Colleges, Catapults, and elite professional institutions to design each route, alongside employers and professional bodies.

3.15 The government will improve destination data to enable informed choices. The government is supporting the development of online portals to present all post-16 learning options to young people in a user-friendly way, and is strengthening the provision of destination and earnings data. The new careers and enterprise company will encourage greater collaboration between schools, colleges and employers, helping young people to access the best advice.

3.16 The government wants strong local areas and employers to take a leading role in establishing a post-16 skills system that is responsive to local economic priorities. The government will make an offer to local areas:

- first, the government will invite local areas to participate in the reshaping and re-commissioning of local provision to set it on an efficient and financially resilient footing. A differentiated approach to local involvement will be adopted which will enable areas with the strongest governance and levers to shape provision, building on the skills flexibilities agreed with Greater Manchester, London and Sheffield. These devolution packages could be extended to other regions. The government anticipates that many colleges will be invited to specialise according to local economic priorities, to provide better targeted basic skills alongside professional and technical education, and that some will be invited to become Institutes of Technology
- second, following on from this restructuring process, the government will enable local involvement in the ongoing commissioning of provision, putting power in the hands of people who are best placed to tailor provision to local economic needs

3.17 The government will move away from the funding per qualification model for adult learners and, with input from local areas and employers, will develop options to ensure provision is targeted at training with the greatest impact.

3.18 The government will set out more details of these reforms in the autumn.

4 World-leading universities, open to all who can benefit

4.1 The UK performs well above the OECD average in terms of higher level skills and is home to 4 out of the world's top 10 universities, second only to the US.[1] This represents an important competitive advantage, as technological change continues to increase demand for higher skilled roles. However, further reform is required to ensure the long-term sustainability of investment in universities.

4.2 The government is committed to maintaining the UK's world class higher education system and making it accessible to all who are qualified and wish to study, particularly students from disadvantaged backgrounds, while also meeting its fiscal objectives. Since 2010 student participation has increased, with a higher proportion of students from disadvantaged backgrounds applying to and entering higher education than ever before.[2] This ambition to widen participation has underpinned all the reforms to higher education finance since 2010 and continues to be a government priority.

4.3 The government has therefore committed for the first time to removing the cap on student numbers. This means that thousands more students can access higher education who were not able to previously, widening access to those who have the grades and can gain from university.

4.4 The government will do more to help students with the cost of living while studying, and will increase the cash available to English students from low and middle income backgrounds. There is evidence that students are more concerned about the level of support they receive while studying than the long-term repayment of their income contingent loans. [3]Maintenance loan support will rise to £8,200 a year for those studying away from home and outside London. This is the highest ever level and will come entirely as an income-dependent loan.

4.5 The expansion of higher education relies on funding being put onto a sustainable footing in the long term. The returns to individuals from a degree are high: the average male graduate will earn £170,000 more over his lifetime, and a female graduate will earn £250,000 more, than someone with whose highest qualification is A-levels.[4] The government will therefore ask graduates to meet more of the costs of their degrees once they are earning, according to their income. From the 2016-17 academic year, maintenance grants will be replaced by maintenance loans for new students, paid back only when their earnings rise above £21,000 a year.

4.6 This change makes it even more important that the long term costs of the student loan book remain affordable and transparent. The government will consult on freezing the repayment threshold at £21,000 for five years and will also review the discount rate applied to student loans and other transactions to bring it into line with the government's long-term cost of borrowing.

[1] QS World University Rankings, 2014-15; *UK Skill Levels and International Competitiveness*, 2013, Derek L Bosworth, August 2014

[2] *End of Cycle Report*, The Universities and Colleges Admissions Service (UCAS), 2014; *UK application rates by country, region, constituency, sex, age and background report*, The Universities and Colleges Admissions Service (UCAS), 2015

[3] *Student Funding Panel: an analysis of the design, impact and options for reform of the student fees and loans system in England*, Universities UK, June 2015

[4] *The Impact of University Degrees on the Lifecycle of Earnings: some further analysis*, Walker and Zhu, 2013

Excellence in teaching

4.7 The government will introduce a new Teaching Excellence Framework to sharpen incentives for institutions to provide excellent teaching, as currently exist for research. This will improve the value for money and return on investment for both students and the government, and will contribute to aligning graduate skills and expectations with the needs of employers. The government will consult later this year on how a Teaching Excellence Framework can be developed, including outcome-focussed criteria and metrics. The Teaching Excellence Framework will inform student decision-making, continue to support a high average wage premium for graduates and ensure that students' hard-won qualifications keep their value over time.

4.8 To support teaching excellence, the government will allow institutions offering high quality teaching to increase their tuition fees in line with inflation from 2017-18, and will consult on the mechanisms to do this. This will reward excellent institutions with higher fee income, while ensuring students get good value from the tuition loans that the government underwrites.

Opening the market to new and alternative providers

4.9 Widening the range of high quality higher education providers can stimulate competition and innovation, increase choice for students, and deliver better value for money. The government will remove barriers preventing alternative providers from entering and growing in the market, and adopt a risk-based approach that safeguards quality.

4.10 To enable the best new providers to compete on a level playing field with established universities, the government will introduce a clearer and faster route to degree awarding powers for those assessed to offer the best quality education. As part of the review of validation arrangements, the government will explore options to allow the best providers to offer degrees independently of existing institutions before they obtain degree awarding powers.

4.11 The government will also free up student number controls for the best alternative providers by introducing a performance pool of places from 2016-17, which will allocate additional student places to the best providers. The government will continue to monitor the quality of courses offered by providers and will impose sanctions on those where quality is not high enough.

Expanding opportunities for postgraduate study and research

4.12 It is also essential that the UK's research base has the right skills. The government has announced an intention to introduce income contingent loans for postgraduate taught Masters courses and PhDs. Following the consultation launched in March 2015, the government will set out details of how these loans will be delivered later this year.

5 A modern transport system, with a secure future

5.1 Infrastructure expands the productive capacity of the economy by reducing transaction costs and by integrating and enlarging markets. It raises the returns on private investment and enables greater specialisation and economies of scale. This chapter focusses on the importance of modern transport infrastructure.

5.2 Transport has a vital role to play by bringing businesses and people closer together and fostering the agglomeration economies that make cities work. Transport connects people to jobs and products to markets, it underpins supply chains and logistics networks, and it is fundamental to domestic and international trade. The connectivity, condition and capacity of a country's transport network is therefore critical for productivity.

5.3 England's roads carry over 95% of all passenger journeys and are used for over 85% of journeys by distance.[1] However, the road network has suffered from a lack of investment by successive governments, and the cost of this is clear:

- connectivity: since 1990 France has built 2,700 miles of motorway, more than the entire length of the UK motorway network[2]
- condition: there is an estimated backlog of maintenance works on the local road network of up to £8.6 billion[3]
- capacity: levels of congestion on the road network are high and rising, and by 2040 the equivalent of more than 100 million working days could be lost to traffic congestion unless action is taken[4] (Chart 5.A)

5.4 As a result of this, the World Economic Forum ranks the UK 30th in the world for the quality of its road network, behind Namibia and Puerto Rico.[5] The government has already taken decisive action to start to turn this around and ensure the country has a road network it can be proud of, and this document sets out the next stage of this plan.

5.5 Railways are also important, with over 4.3 million journeys being made by rail every day.[6] Since privatisation in the mid-1990s, there has been sustained growth in rail passenger demand, at a rate far in excess of any other mode of transport. Over the last 10 years, passenger journeys in Great Britain have increased by 57%.[7] The government has made a commitment to upgrading the railway and bringing this largely Victorian asset into the 21st century. As problems at Network Rail have become clear, the government has acted decisively to start to put the rail investment programme back on a sustainable footing. This plan sets out the next steps.

[1] *National Travel Survey*, Department for Transport, 2013

[2] *Action for Roads*, Department for Transport, 2013

[3] Internal analysis conducted by the Department for Transport in 2015. This is based on a central spot estimate from a range of between £4.3 billion and £8.6 billion.

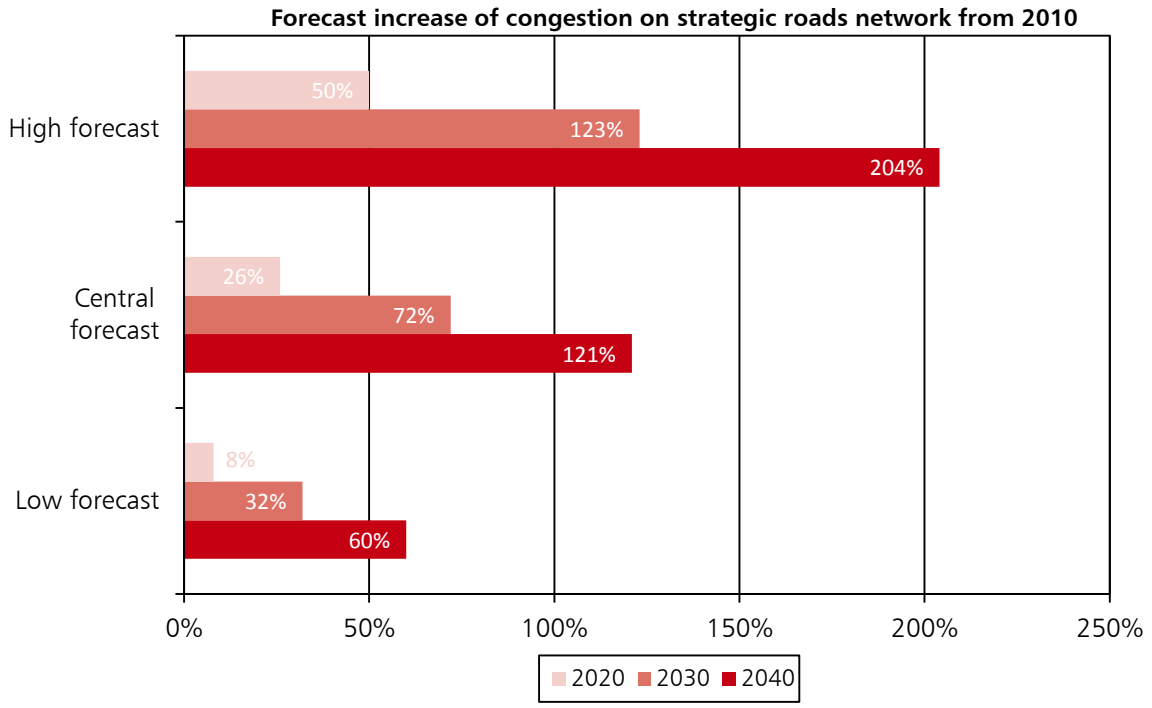
[4] *Action for Roads*, Department for Transport, 2013

[5] World Economic Forum Competitiveness Index 2014-15

[6] Passenger Rail Usage statistics, Office of Rail and Road, June 2015

[7] Passenger Rail Usage statistics, Office of Rail and Road, June 2015

Chart 5.A: Forecast of congestion on the strategic road network in England



Source: Department for Transport: National Policy Statement for National Networks, 2014.

5.6 Airports provide critical international connectivity. Aviation contributes £18 billion per year to the UK economy and supports 220,000 jobs.[8] The connections created by air transport enable beneficial activities such as Foreign Direct Investment (FDI), business clusters and specialisation, as well as creating other positive spill-over effects. Air connectivity facilitates productivity benefits by boosting international trade. Around £4.1 trillion of goods now travel by air each year, equating to around 35% of all world trade by value.[9] However, the Airports Commission's analysis suggests that the costs of not addressing capacity constraints in the future could amount to £18-20 billion of costs to users and providers of airport infrastructure, and £30-45 billion of costs to the wider economy.[10]

Establishing a Roads Fund

5.7 In the last Parliament the government published the first ever Roads Investment Strategy (RIS), a five year plan to deliver an unprecedented £15 billion of investment in strategic roads over the course of the current Parliament. This was underpinned by comprehensive institutional reforms to establish Highways England as a new government-owned company, tasked with operating more commercially and efficiently to deliver this programme, together with the creation of the new Office for Rail and Road which will serve to ensure the efficiency of the new company.

5.8 The government is determined to lock in these reforms for the long term. To ensure that future roads investment is sustainable, the Summer Budget 2015 announced a reform to Vehicle Excise Duty (VED) to create a Roads Fund. VED will be reformed for cars registered from April 2017 to make it fairer for motorists and reflect improvements in new car CO2 emissions. The

[8] *Aviation Policy Framework*, Department for Transport, 2013

[9] International Air Transport Association, December 2013

[10] *Airports Commission Interim Report*, Airports Commission, December 2013

new VED system will be reviewed as necessary to ensure that it continues to incentivise the cleanest cars.

5.9 From 2020-21, the government guarantees that all revenue raised from VED in England will be allocated to a new Roads Fund and invested directly back into the strategic road network. This will ensure a better future for the nation's motorways and major trunk roads so that they can better support a growing and highly productive economy, by creating a clear commitment to high and stable levels of investment over the long term. This certainty will also allow Highways England to properly plan for the future; it will allow the supply chain to invest for the future with confidence; and it will help both work together to drive down efficiencies and unit costs.

5.10 As a result of this reform, the government will develop a second Road Investment Strategy for the period 2020-25 which, as a result of the Roads Fund, will be underpinned by another multi-billion pound programme of investment. The second Roads Investment Strategy will be published before the end of the Parliament.

A more efficient, reliable and better rail network

5.11 To keep up with growing demand for rail services, the UK needs to continue with sustained investment to maintain and upgrade its largely Victorian infrastructure. The government has made a clear commitment to improve the rail network across the UK, backed by £38 billion of investment. This is a complex and challenging task, but the delays and cost increases reported on this rail investment programme are unacceptable, and the government will act to put the programme back on track.

5.12 The government has appointed Sir Peter Hendy, formerly the Commissioner of Transport for London, as the new Chairman of Network Rail. The government has asked Sir Peter Hendy to bring his experience and expertise to bear on doing what is necessary to ensure Network Rail can deliver effectively and operate the railway safely, and in particular to report by autumn 2015 with a plan to get the rail investment programme back onto a sustainable footing.

5.13 The government will also take further action to improve incentives and drive improvements in Network Rail and the wider rail industry:

- the government has asked Sir Peter Hendy and Mark Carne, Chief Executive of Network Rail, to continue with the work started in Network Rail to devolve more power to route managers closer to the front line, so that the railway is more focussed on delivering what passengers need and to drive comparative benchmarking of the efficiency and effectiveness of individual routes – to drive up performance across the network
- the government will also change the way it channels public money through the industry, directing it through the train operating companies, so that Network Rail focusses firmly on the needs of train operators and, through them, passengers. This will put the customers of the railway back in the driving seat in demanding efficiency and improvements that matter to them, making the best use of scarce capacity on the rail network
- the government will introduce a new approach to station redevelopment and commercial land sales on the rail network, building on the experience of successfully regenerating land around Kings Cross Station and Stratford in East London. The government will establish a dedicated body to focus on pursuing opportunities to realise value from public land and property assets in the rail

network, to both maximise the benefit to local communities and reduce the burden of public debt

5.14 The government has also asked Nicola Shaw, Chief Executive of High Speed 1, to advise the government on how it should approach the longer-term future shape and financing of Network Rail. Ms Shaw will work closely with Sir Peter Hendy in conducting her work, which will be concluded before Budget 2016.

Taking a decision on airport capacity in the south east

5.15 In the last Parliament the government tasked the Airports Commission with considering how the UK could maintain its status as an international hub for aviation. The Commission concluded that there was a need for further airport capacity in the south east of England. The government will now assess the Commission's analysis and decide by the end of the year whether it agrees with that assessment and, if so, the best route for achieving planning consents and getting a new runway built.

6 Reliable and low-carbon energy, at a price we can afford

6.1 Energy underpins the operation of a successful and productive economy. It is important that the government strikes the right balance in meeting the three challenges of security of supply, affordability and sustainability.

6.2 Achieving security of supply consistently allows individuals and firms to invest and plan ahead with the confidence that energy networks will be able to support their future needs, while competition, research and innovation within the energy sector can help businesses by lowering bills.

6.3 The government is committed to attracting much-needed investment in energy infrastructure and production, ensuring security of supply whilst promoting competition in energy markets and networks to keep bills as low as possible. Alongside this, the government will also seek to meet the UK's climate change commitments cost-effectively, including promoting innovation to make a cost-effective transition to a low carbon economy.

6.4 The government aims to improve productivity in energy generation, production, supply and usage. This will be achieved through:

- a strengthened role for competitive markets. The government welcomes the provisional findings of the Competition and Markets Authority's energy market investigation, and will ensure that energy markets work better for households and businesses across the country. As a first step towards this, the government will aim to introduce 24 hour switching by the end of 2018, working with Ofgem
- reforming the oil and gas fiscal and regulatory regime to maximise economic recovery from the UK Continental Shelf by driving down costs and increasing production efficiency
- developing the shale industry, which has the potential to increase energy security whilst supporting thousands of jobs in producing areas, including through a sovereign wealth fund for communities that host shale gas development
- continuing the long term decarbonisation of the UK's energy sector through a framework that supports cost effective low carbon investment
- seeking to ensure that EU energy policy supports affordable and secure energy for the UK, and that the European Commission's Energy Union package strengthens the single market, improves physical energy interconnections, encourages research and development, and supports cost-effective decarbonisation
- delivering a significant expansion in new nuclear power in the UK. The Hinkley Point C power station alone could generate 7% of the UK's electricity needs[1]

[1] Job stats from EDF

- the government is also conducting a review of business energy tax policy to improve and simplify the landscape

7 World-class digital infrastructure in every part of the UK

7.1 Reliable and high quality fixed and mobile broadband connections support growth in productivity, efficiency and labour force participation across the whole economy. They enable new and more efficient business processes, access to new markets and support flexible working and working from home. Investment in high speed broadband will support long-term economic growth, with GVA increasing by £6.3 billion, causing a net increase of 20,000 jobs in the UK by 2024.[1] Geographic coverage and take-up of superfast broadband in the UK is already the highest of the 5 largest EU economies.[2] The government's superfast broadband programme is passing an additional 40,000 premises every week – superfast speeds of at least 24Mbps will be available to 95% of UK households by 2017.

7.2 By reducing regulatory red tape and barriers to investment, the government will support the market to deliver the internationally competitive fixed and mobile digital communications infrastructure the UK's businesses need to thrive and grow, and which will enable the UK to remain at the forefront of the digital economy. The government is working with business so that the market can play the lead role in delivering against the ambitions set out in the Digital Communications Infrastructure Strategy, published in March, of near-universal 4G and ultrafast broadband coverage.

7.3 The government will take decisive action to make it easier for the market to roll out the fixed and mobile infrastructure that the UK needs:

- the government proposes to extend permitted development rights to taller mobile masts in both protected and non-protected areas in England. A call for evidence on these proposals has been published today
- the government intends to introduce legislation in the first session of this Parliament to reform the Electronic Communications Code, which regulates the relationship between electronic communications network operators and site providers
- the government will be consulting later this year on implementation of the EU Directive on measures to reduce the cost of deploying high-speed communications networks
- the government is also considering making the 2013 planning relaxations supporting fixed high speed broadband infrastructure rollout permanent

7.4 These measures will make it cheaper and easier for providers to build the infrastructure UK businesses need.

7.5 Electromagnetic spectrum is a valuable and scarce resource. By securing more efficient use of public sector spectrum (while safeguarding departments' ability to deliver critical operational public services), the government will be able to share or release more of its spectrum, realising

[1] *UK Broadband Impact Study*, SQW Consulting, 2013.
[2] *European Broadband Scorecard Q1 2015*, Ofcom, 2015.

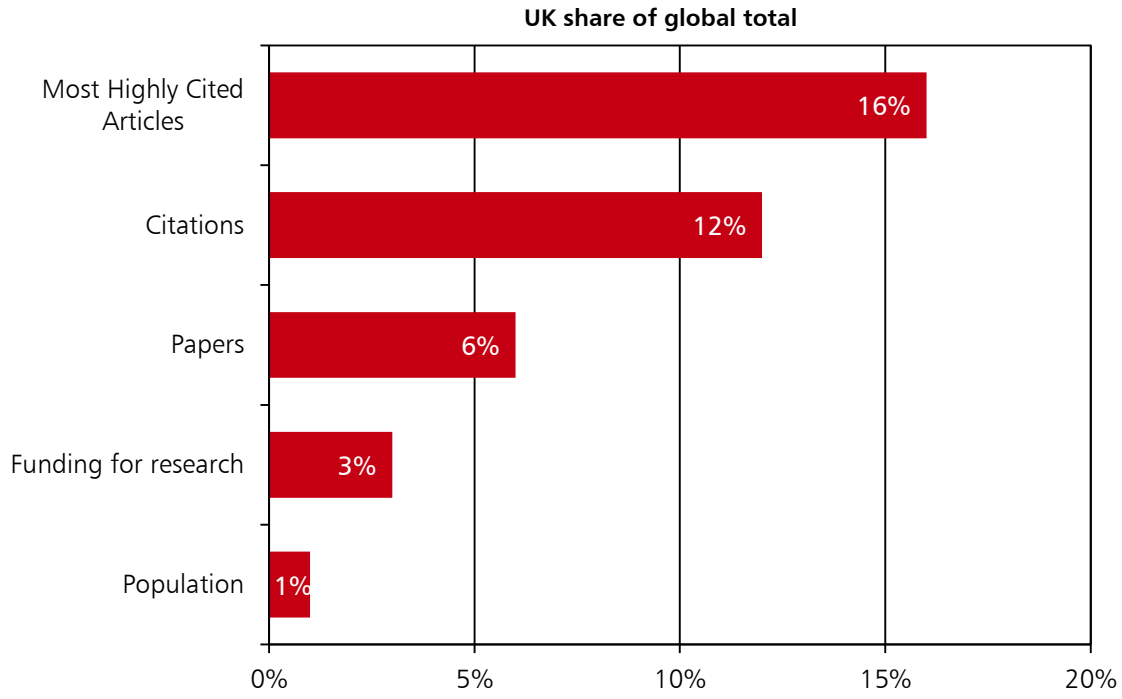
wider economic benefits both in terms of generating capital receipts and by supporting digital communications innovation and the development of new technologies. To deliver this, the government has implemented a new model for the centralised management of public sector spectrum.

8 High quality science and innovation, spreading fast

8.1 The creation and application of new ideas is critical for long-run productivity growth. There is clear and robust evidence of a link between R&D spending and national productivity.[1]

8.2 Science and innovation is an area of great UK strength. The UK produces 16% of top quality published research findings, with less than 1% of the world's population.[2] Foreign investors are drawn by the strength of UK research, including the opportunity for knowledge sharing with universities and access to high quality R&D personnel. The UK is ranked 4th in the world for business and university collaboration, and attracts more R&D funded from abroad than Finland, Russia, Canada, Japan and China combined.[3]

Chart 8.A: The UK's strengths in science: proportion of research inputs and outputs



Source: Elsevier International Comparative Performance of the UK Research Base - 2013.

8.3 To build on these strengths, the UK needs to ensure that it retains its position of international excellence in science, while increasing its strategic focus. The last government maintained the ring-fenced science budget in cash terms at £4.6 billion per year.[4] But there is more to be done to ensure all elements of the funding system are aligned with areas and markets of strategic importance and potential for the UK economy.

[1] *The policy and institutional drivers of economic growth: new evidence from growth regressions*, OECD Economics Working Paper 843 (2011)
[2] *International Comparative Performance of the UK Research Base*, Elsevier, 2013
[3] *Global Competitiveness Index 2014-15*, The World Economic Forum, 2014; Main Science and Technology Indicators, OECD, 2015
[4] *Spending Round 2013*, HM Treasury

8.4 The UK's research benefits from strong links between universities and industry, but there is still further to go in commercialising discoveries made in the research base and in ensuring the diffusion and adoption of these discoveries. The UK ranks second overall in the Global Innovation Index, but performs poorly on SMEs introducing product or process innovations.[5] Even adjusting for differences in the UK's industrial structure, the private sector under-invests: R&D investment from industry has stagnated at 1.1% of GDP since 1995, compared to an OECD average of 1.6%.[6]

Excellence in science

8.5 The UK's system of funding science is central to ensuring the best researchers have the flexibility to innovate and to maintain the UK's position as a world leader. The commitment to excellence, facilitated through a dual support system, must remain absolute.

8.6 But the wealth and breadth of possibilities in science and innovation mean that prioritisation is needed. The government will ensure these strategic choices are made through:

- investments in national infrastructure; the government will deliver on the science capital commitment, investing £6.9 billion in the UK's research infrastructure up to 2021
- ensuring the UK's excellent science has a focus on those areas with greatest potential, from genetics to quantum technology
- clear strategies in cross-departmental areas of research interest such as health, where the government works closely with medical research charities. The Accelerated Access Review offers a significant opportunity to improve quality of care and cost effectiveness, and the UK is leading the fight against the global health risk posed by antimicrobial resistance

8.7 It is crucial that the UK supports excellence wherever it is found. The government will therefore invite universities, cities, Local Enterprise Partnerships (LEPs) and business to work with the government to map the strengths of different regions through a series of science and innovation audits. These will provide a new, powerful way to build on different regions' strengths and to maximise the economic impact from the UK's research base.

8.8 Sir Ian Diamond's review highlighted that collaboration has an important role to play, both in improving the efficiency and supporting the quality of research. The government encourages universities to strengthen local collaboration wherever this will achieve these objectives.

8.9 The government will also introduce new Regius Professorships in order to recognise excellence in universities across the UK. The government will launch a competition later this year, with a view to making awards in early 2016 to celebrate the Queen's 90th birthday.

8.10 The government has asked Sir Paul Nurse to examine how Research Councils can evolve to support research in the most effective ways. His independent review, which will report later this year, will help to inform the government's decision-making in the Spending Review.

Industry collaboration and commercialisation of research

8.11 The government will continue to support universities in collaborating with industry and commercialising research. The government therefore welcomes Professor Dame Ann Dowling's review on this topic. The report acknowledges recent progress but has identified where more

5 The Global Innovation Index 2014, Cornell University, INSEAD and WIPO, 2014; EU Innovation Union Scoreboard, European Union, 2015

6 Main Science and Technology Indicators, OECD, 2015

can be done. The government will respond in full by the Spending Review, including on how to make it easier for business to find help and support from universities and government. The government's ambition is that UK universities will continue to increase their collaboration with industry to drive research commercialisation, and increase the income they earn from working with business and others to £5 billion per annum by 2025.

8.12 The government can confirm significant industrial support for specific science investments including £128 million in the UK Collaboration for Research in Infrastructure and Cities (UKCRIC) and £200 million industry funding from IBM to drive forward Big Data research at Hartree.

8.13 At the March Budget 2015 the government announced a Research Partnership Investment Fund competition of £400 million to support capital investment in scientific grand challenges. The government can confirm that this will focus on proposals that not only meet expectations for excellent research, but also recognise the potential for local economic growth, local collaboration and leverage.

8.14 With close to €80 billion of funding available from 2014 to 2020, Horizon 2020 is the principal means of financing research and innovation projects using EU budget funds. Under the predecessor to Horizon 2020, the Seventh Framework Programme for Research (FP7), the UK performed well amongst academia and researchers, but less well for business uptake. Improving UK business participation in Horizon 2020 will contribute to the drive to commercialise UK research.

Innovation and industry

8.15 The government has made a clear commitment to make the UK the best place in Europe to innovate and create the ideas that help grow a business. Significant support for research and development and bringing new products to market is provided through Innovate UK, and also through sector-specific funds including the Aerospace Technology Institute (ATI) and the Advance Propulsion Centre (APC). The government will work to ensure that the means through which businesses access this support are simplified and customer-focussed.

8.16 Support to business will be focussed on where it will deliver the most innovation, growth and jobs. The government will use its Challenger Businesses Programme to identify and address barriers to expansion for early-stage disruptive businesses.

8.17 The government has also created an extensive network of Catapult centres, bringing together businesses, scientists and engineers to drive the commercialisation of technology. Innovate UK, working with Research Councils, has now identified further areas where a Catapult might be the right way to ensure the UK is at the forefront of commercialising technologies which offer global opportunities, and will come forward with proposals shortly.

B Section B: A dynamic economy

It is not just the quality of skills, machines, or even the technology available that matters for productivity; it is also how well they are matched to their best use. This relies on a dynamic economy where good ideas spread rapidly, workers are well matched to jobs, productive firms can scale up, and where people move into jobs that use their skills and can own homes close to where they want to work.

The UK already ranks highly on many measures of economic dynamism, [1] but there is no room for complacency and there remain significant areas of weakness that must be addressed. This plan addresses particular challenges in the form of a planning system regarded by many as one of the most significant constraints facing the economy, bringing delay and inflexibility; a labour market that has performed well but still does not make use of everyone's talents; the need to increase exports; and a financial sector that has, in recent years, acted as a drag on productivity through both its own performance and its impact on the wider economy.

Cities are at the heart of a dynamic economy, providing deep markets for labour and enabling the rapid diffusion of ideas and vibrant competition between firms. The concentration of activity within cities itself contributes to productivity through the sharing of knowledge and ideas, the pooling of labour, the specialisation and matching of supply and demand and the sharing of infrastructure. This plan sets out further measures to build dynamic, resurgent cities and to build up a Northern Powerhouse. The Northern Powerhouse is a vision based on the solid economic theory that while the individual cities and towns of the north are strong, if we enable them to pool their strengths, they could be stronger than the sum of their parts.

[1] Individual references sourced in chapters.

9 Planning freedoms and more houses to buy

9.1 The UK has been incapable of building enough homes to keep up with growing demand. This harms productivity and restricts labour market flexibility, and it frustrates the ambitions of thousands of people who would like to own their own home.

Building more homes that people can afford to buy

9.2 An effective land and housing market promotes productivity by enabling the economy to adapt to change, helping firms to locate where they can be most efficient and create jobs, and enabling people to live and own homes close to where they work.

9.3 Housing starts fell by nearly two-thirds between 2007 and 2009,[1] and the number of first time buyers fell by more than 50% between 2006 and 2008.[2] The government implemented significant reforms over the last Parliament to turn this situation around, including reforms to the planning system, and support for homeownership, particularly first time buyers.

9.4 An excessively strict planning system can prevent land and other resources from being used efficiently, impeding productivity by:

- increasing the cost and uncertainty of investment. Previous estimates have put transaction costs for major housing developments at £3 billion per annum[3]
- hindering competition by raising barriers to entry, adaptation and expansion
- constraining the agglomeration of firms and the mobility of labour, with previous estimates suggesting that planning constraints on commercial space are the equivalent of a 250% regulatory tax on office space[4]
- encouraging firms, households and financial institutions to speculate on land, diverting resources away from productive activities

9.5 As a result, the government made significant reforms to the planning system over the last Parliament, introducing a new National Planning Policy Framework, streamlining guidance from over 7,000 pages to a simple online guide, and reducing regulation for house builders. For aspiring home owners, the government reinvigorated the Right to Buy, introduced Help to Buy, and delivered a stamp duty cut for 98% of homebuyers who pay it.[5]

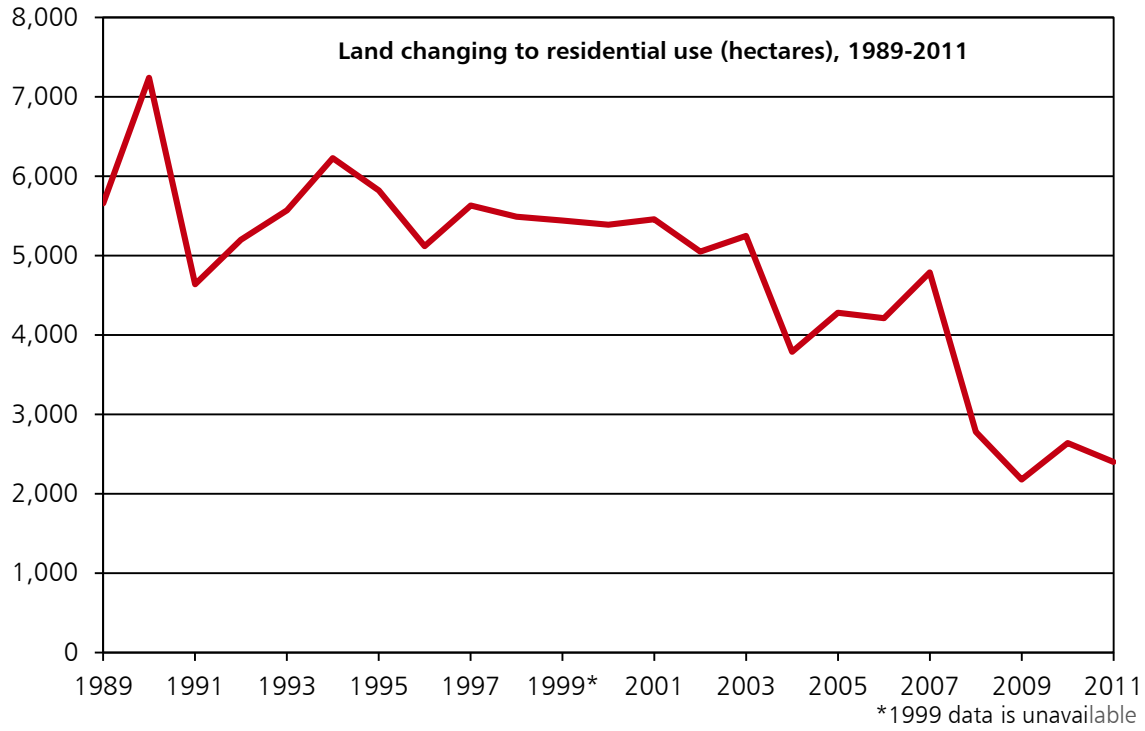
9.6 This approach is working: planning permissions and housing starts are at 7 year highs,[6] the number of first time buyers last year rose by more than 20%,[7] and more than 100,000 households have been helped onto or up the housing ladder by Help to Buy.[8]

[1] *Permanent Dwellings Started*, Department for Communities and Local Government, May 2015
[2] *Halifax First Time Buyer Review*, Lloyds Banking Group, January 2015
[3] *Housing Supply and Planning Controls*, Michael Ball for NHPAU, January 2010
[4] *Office Supply Restrictions in Britain*, Paul Cheshire and Christian Hilber, 2008
[5] Autumn Statement 2014, HM Treasury
[6] *Permanent dwellings started*, Department for Communities and Local Government, May 2015; Housing Pipeline report, Home Builders Federation, March 2015
[7] *Halifax First Time Buyer Review*, Lloyds Banking Group, January 2015
[8] *Help to buy creates 131 new homeowners a day*, Department for Communities and Local Government, June 2015

9.7 There remains more to do. As the London School of Economics (LSE) Growth Commission found, 'under-supply of housing, especially in high-growth areas of the country has pushed up house prices. The UK has been incapable of building enough homes to keep up with growing demand'.[9]

9.8 This plan sets out the steps the government will take to ensure more homes are built that people can afford, through planning reform, progress on delivering 200,000 Starter Homes and the extension of the Right to Buy, and reforms to the Buy to Let market.

Chart 9.A: Reduction of land changes to residential use over time



Source: Department for Communities and Local Government: Live Table P226 'Land Use Change: residential land'.

Releasing land for the homes people need

9.9 Over the previous Parliament, the government removed top-down regional strategies and placed local authorities at the forefront of deciding how to meet the need for housing through their local plans.

9.10 It is vital that local authorities use these powers to put in place local plans that set the framework for the homes and jobs local people need. The government will take further action to ensure that local authorities put local plans in place by a set deadline to be confirmed by summer recess. The government will publish league tables, setting out local authorities' progress on providing a plan for the jobs and homes needed locally. Where they are not, the Secretary of State for Communities and Local Government will intervene for those local authorities that do not produce them, to arrange for local plans to be written, in consultation with local people.

9.11 The government will also take steps to ensure that local plans are more responsive to local needs. The government will bring forward proposals to significantly streamline the length and

[9] *Investing for Prosperity*, London School of Economics Growth Commission, September 2013

process of local plans, helping to speed up the process of implementing or amending a plan. The government will also bring forward proposals to improve cooperation between local authorities. The National Planning Policy Framework is clear that local authorities should look to meet their housing need, as far as is possible within constraints. Where they cannot meet their need in full, they should cooperate with other local authorities to do so. The government will strengthen guidance to improve the operation of the duty to cooperate on key housing and planning issues, to ensure that housing and infrastructure needs are identified and planned for.

9.12 Areas around commuter transport hubs offer significant potential for new homes. The government will work with mayors in London and across the country to use new powers in the Devolution Bill to use development corporations to deliver higher-density development in designated areas. The government will consider how policy can support higher density housing around key commuter hubs. The government will also consider how national policy and guidance can ensure that unneeded commercial land can be released for housing.

A zonal system for brownfield land

9.13 The government is committed to an urban planning revolution on brownfield sites, including funding to provide infrastructure, strong local leadership to shape development and assemble sites, and the removal of unnecessary planning obstacles.

9.14 Previous studies have found that the country's planning system – where development proposals require individual planning permission and are subject to detailed and discretionary scrutiny – can create the sort of "slow, expensive and uncertain process" that reduces the appetite to build.[10] The government is clear on the need to promote use of brownfield land, and will remove all unnecessary obstacles to its re-development, including these sorts of planning obstacles.

9.15 The government has already committed to legislating for statutory registers of brownfield land suitable for housing in England. The government will go further by legislating to grant automatic permission in principle on brownfield sites identified on those registers, subject to the approval of a limited number of technical details. On brownfield sites, this will give England a 'zonal' system, like those seen in many other countries, reducing unnecessary delay and uncertainty for brownfield development.

9.16 In the spring, the government consulted on reforms to bring forward more brownfield land for development by making the compulsory purchase regime clearer, faster and fairer for all parties. This first round of reforms will be introduced through legislation in this session of Parliament. A number of additional proposals have been received from that consultation; the government is considering the case for these additional compulsory purchase reforms to further modernise the system, and will bring forward proposals in the autumn. These will allow local authorities and others to drive forward and shape brownfield development, and will not alter the principle of Secretary of State sign-off on compulsory purchase orders.

Improving the planning process - ensuring planning decisions are made on time

9.17 Evidence suggests that delays in processing planning applications may be a significant factor preventing housing supply from responding to upturns in the market.[11] Significant progress has been made, with the proportion of major applications dealt with on time rising

[10] *Planning Delay and Responsiveness of English Housing Supply*, Michael Ball, 2011
[11] *Planning Delay and Responsiveness of English Housing Supply*, Michael Ball, 2011

from 58% in 2012-13 to 77% in 2014-15.[12] The government wants to see further progress, with all planning decisions made on time. This is particularly important for SMEs. The government will therefore:

- legislate to allow major infrastructure projects with an element of housing to apply through the Nationally Significant Infrastructure Regime (NSIP)
- tighten the planning performance regime, so that local authorities making 50% or fewer of decisions on time are at risk of designation
- legislate to extend the performance regime to minor applications, so that local authorities processing those applications too slowly are at risk of designation
- introduce a fast-track certificate process for establishing the principle of development for minor development proposals, and significantly tighten the 'planning guarantee' for minor applications
- repeat its successful target from the previous Parliament to reduce net regulation on housebuilders. The government does not intend to proceed with the zero carbon Allowable Solutions carbon offsetting scheme, or the proposed 2016 increase in on-site energy efficiency standards, but will keep energy efficiency standards under review, recognising that existing measures to increase energy efficiency of new buildings should be allowed time to become established
- introduce a dispute resolution mechanism for section 106 agreements, to speed up negotiations and allow housing starts to proceed more quickly

More devolved planning powers

9.18 Housing is a national priority, and the government will work with mayors and Combined Authorities to provide the tools they need.

9.19 In London, the Mayor's 2020 Vision has set out the scale of the challenge, with at least 42,000 homes needed a year over the next 20 years. The government has already taken significant steps, including the Chancellor and Mayor jointly announcing £400 million investment to support 20 Housing Zones on brownfield sites. Housing starts in London have risen by 24% since 2012-13.[13]

9.20 Building on this investment, the Chancellor set out in the Long Term Economic Plan for London that the government would enter into discussions for the devolution of major new planning powers to the Mayor of London, beginning with powers over wharves and sightlines, to be used in consultation with Londoners. The government confirms its intention to proceed with devolution of wharves and sightlines, and will also look to bring forward proposals to allow the Mayor to call in planning applications of 50 homes or more, allowing him to support more planning applications that will help to meet London's needs.

9.21 As the Mayor's housing strategy set out, any increase in housing supply in London will be overwhelmingly brownfield development, and is likely to involve increasing densities.[14] Helping London to 'build up' in this way will reduce the need to 'build out', helping to provide homes for Londoners while protecting the countryside. Planning processes can create unnecessary burdens for proposals seeking to increase density on brownfield land. The government is keen to

[12] *Planning applications received and decided by district planning authorities by speed of decision*, Department for Communities and Local Government, June 2015

[13] *Housebuilding: permanent dwellings started and completed, by tenure and LEP*, Department for Communities and Local Government, May 2015

[14] *Homes for London*, the London Housing Strategy

support the Mayor's aims, where there is local consent. The government will therefore work with the Mayor of London to bring forward proposals to remove the need for planning permission for upwards extensions for a limited number of stories up to the height of an adjoining building, where neighbouring residents do not object. In cases where objections are received, the application will be considered in the normal way, focussed on the impact on the amenity to neighbours.

9.22 The government will devolve new powers to the future Mayor of Greater Manchester, giving them the tools to drive forward complex, brownfield developments. The government will bring forward proposals to allow the mayor to produce Development Corporations, and promote Compulsory Purchase Orders. These powers will be exercisable with the consent of the Cabinet member representing the borough in which the power is to be used.

Starter Homes and Right to Buy

9.23 The government will deliver its commitment to get 200,000 Starter Homes built by 2020, at a 20% discount for young first time buyers. The government is bringing forward proposals to help deliver this commitment, which include:

- requiring local authorities to plan proactively for the delivery of Starter Homes
- extending the current exception site policy, and strengthening the presumption in favour of Starter Home developments, starting with unviable or underused brownfield land for retail, leisure and institutional uses
- enabling communities to allocate land for Starter Home developments, including through neighbourhood plans
- bringing forward proposals to ensure every reasonably sized housing site includes a proportion of Starter Homes
- implementing regulations to exempt these developments from the Community Infrastructure Levy, and re-affirming through planning policy that section 106 contributions for other affordable housing, and tariff-style general infrastructure funds, will not be sought for them
- putting in place new arrangements to monitor their delivery

9.24 The government is committed to extending the Right to Buy to housing association tenants. Since the Right to Buy for council tenants was reinvigorated in the last Parliament, the number of sales has increased by nearly 320%.[15] The government will extend the same opportunity to buy to the tenants of housing associations through the Housing Bill, to be introduced in this session of Parliament.

9.25 In the Spending Review, the government will take further steps to re-focus Department for Communities and Local Government (DCLG) budgets, focussing on supporting low cost home ownership for first time buyers.

Buy to Let

9.26 The current tax system supports landlords over and above ordinary homeowners. Landlords can deduct costs they incur when calculating the tax they pay on their rental income. A large portion of those costs are interest payments on the mortgage. Mortgage Interest Relief was withdrawn from homeowners 15 years ago. However, landlords still get the relief. The ability to

[15] DCLG Live Table 671 (Annual Right to Buy Sales for England)

deduct these costs puts investing in a rental property at an advantage. Tax relief is particularly beneficial for wealthier landlords with larger incomes, as every £1 of finance cost they incur allows them to pay 40p and 45p less tax respectively. The Bank of England has also noted in its recent Financial Stability Report that the rapid growth of buy to let mortgages could pose a risk to the UK's financial stability.

9.27 The government will restrict the relief on finance costs that landlords of residential property can get to the basic rate of tax. The restriction will be phased in over 4 years, starting from April 2017. This will reduce the distorting effect the tax treatment of property has on investment and mean landlords are not treated differently based on the rate of income tax that they pay. It will also start to shift the balance between landlords and homeowners.

10 A higher pay, lower welfare society

10.1 Getting the public finances under control is helping to create the best conditions for sustainable growth. Despite progress during the last Parliament, the welfare bill remains stubbornly and disproportionately high. The welfare system should ensure that people are incentivised and helped to find work which is fairly paid, and that the taxpayer does not subsidise low pay or foot the bill for an unfair system where too many people remain on benefits.

10.2 In the last Parliament, the government started reforming the welfare system to make it fairer and more affordable. Universal Credit, which brings together 6 benefits into 1, represents the most fundamental reform of the welfare system since its inception and will mark a turning point towards a system where work will always pay more than a life on benefits. In addition, the government introduced the household benefit cap to ensure that out of work households would not be better off than the average working family. The Summer Budget 2015 announced further reductions in the household benefit cap, alongside a four year freeze in working-age benefits from 2016-17 to 2019-20 (except disability benefits and statutory payments).

10.3 Full details of the changes to the welfare system are set out in the Summer Budget 2015

10.4 Tackling tax credit spending is also an important part of the plan to move to a higher pay, lower welfare system. The government will therefore reform tax credits (and its successor, Universal Credit) to focus support on families on the lowest incomes. The Summer Budget 2015 also limits support provided through tax credits to 2 children for new cases, and removes the Family Element in tax credits (also for new cases).

10.5 Alongside action on benefit dependency, a key part of the government's commitment to making work pay is to ensure that people can keep more of the money they earn by cutting taxes. Increases in the personal allowance over the parliament have ensured that people can keep more of their earnings. The Summer Budget 2015 announced further increases in the personal allowance to £11,000 in 2016-17. A basic rate taxpayer will be £80 better off in 2016-17, compared to 2015-16 and £905 better off compared to 2010. This is the first step towards meeting the government's commitment to raise the personal allowance to £12,500 by the end of this parliament. The government will legislate to ensure that once it has reached that level, it will always be set at least at the equivalent of 30 hours a week on the National Minimum Wage. This will ensure that those working up to 30 hours on the National Minimum Wage will not pay income tax in the future.

10.6 But there is still further to go to ensure that work always pays. The National Minimum Wage is due to rise to £6.70 an hour in October - the largest real-terms increase since the financial crisis. While productivity growth is key to ensuring that real wages rise across the economy, the government believes that now is the right time to take further action to tackle low pay to ensure that low wage workers can take a greater share of the gains from growth. The government will therefore introduce a new National Living Wage (NLW) for workers aged 25 and above. The government will ask the Low Pay Commission to recommend a path for the new National Living Wage to reach 60% of median earnings by 2020, expected to reach the government's target of over £9 an hour by 2020. To support businesses with the cost of this change, from April 2016 the government will increase the National Insurance contributions Employment allowance from £2,000 to £3,000 a year.

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11 More people with a chance to work and progress

11.1 A productive economy must make the most of its labour force and effectively mobilise people into jobs. A central part of this is to ensure that work always pays, and that people are incentivised and helped to find employment.

11.2 The government has a strong track record on this: both employment and participation in the labour market have been rising rapidly in recent years. The UK's labour market performance has stood out among advanced economies, and recently overtook Canada to have the third highest employment rate in the G7.[1] Employment is around record levels, at 31.1 million, with an extra two million people in work since the start of the last parliament, and unemployment is now very close to pre-recession lows.[2]

11.3 But there is further to go to ensure that as many people as possible are able to find and stay in a job, and the government remains committed to its full employment ambitions. There is no reason why the UK should not have the highest employment rate in the G7, but this will mean continuing to back business, reform welfare and reward work. It will also mean ensuring that all groups in society are given the support they need to find and keep a job.

Enabling employment, so that the UK has the highest employment rate in the G7

11.4 In the last Parliament the government announced a wide range of reforms intended to promote and enable work. Support for employers has been at the forefront of this, with the introduction of the Employment Allowance from April 2014 (which gives businesses up to £2,000 off their National Insurance bill), and the abolition of employer National Insurance Contributions for virtually all people aged under 21 a year later.

11.5 Additional help to find work has been introduced for more specific groups. This has included a more intensive system of support for Jobseeker's Allowance claimants and the Work Programme, an innovative payment-by-results employment support scheme designed to help those who are at most risk of becoming long-term unemployed. But the government wants to ensure no one is left behind and is determined young people should not start life on benefits. So it is introducing a new Youth Obligation for 18-21s on Universal Credit. There will be an intensive regime of support from day one and, after six months, young people will be expected to apply for an apprenticeship, traineeship, gain work-based skills or go on a mandatory work placement to give them the skills and experience they need to get into sustainable employment.

11.6 Increasing employment levels among people with disabilities and health conditions is a key part of the government's aim to achieve full employment. The current system creates a financial incentive to remain on sickness benefits instead of moving closer to the labour market. From April 2017, new claimants of Employment and Support Allowance (ESA) who are placed in the

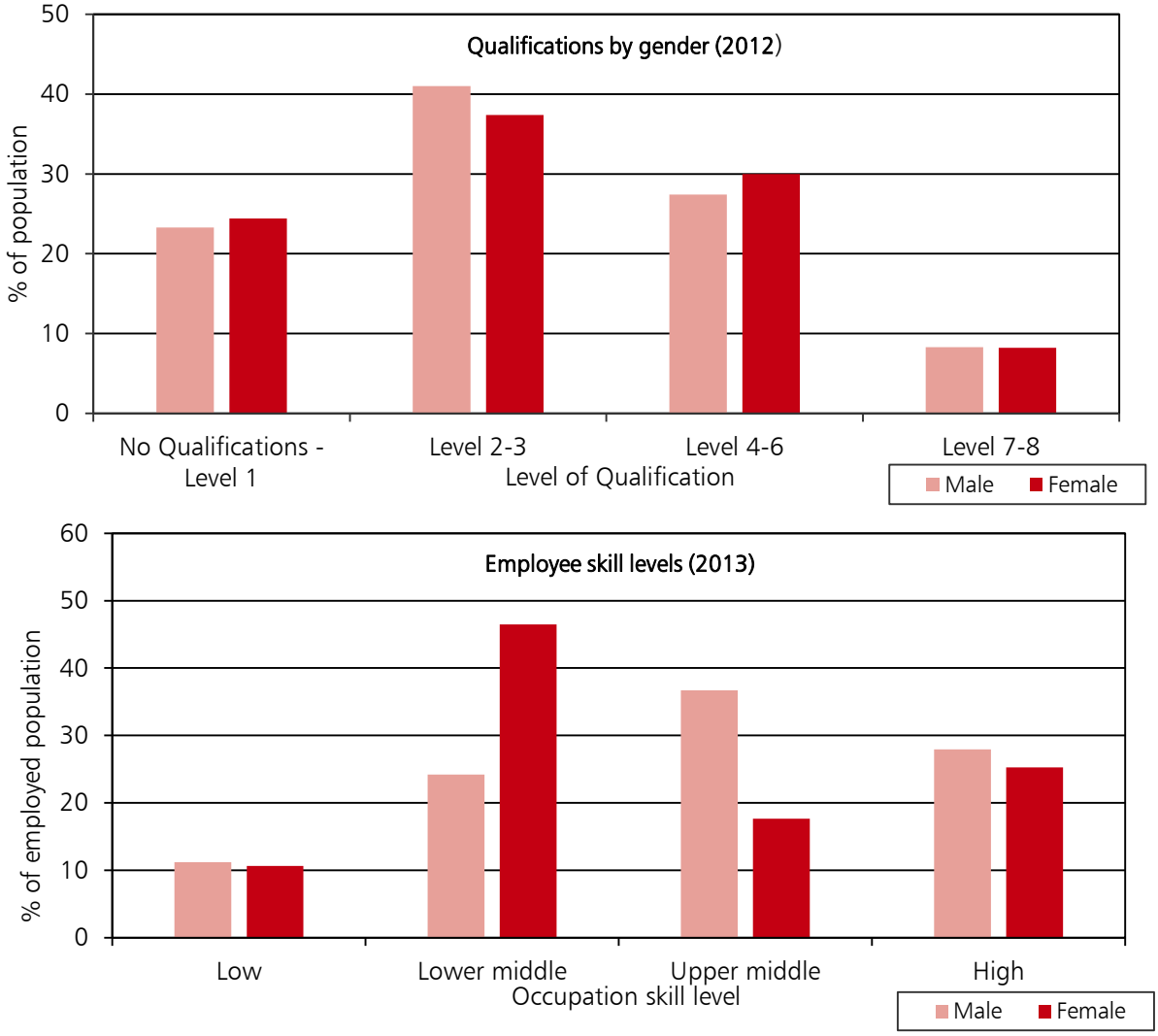
[1] *OECD short term labour market statistics*, Organisation for Economic Co-operation and Development

[2] *Labour Market Statistics*, Office for National Statistics

Work-Related Activity Group will therefore receive the same rate as those claiming Jobseeker's Allowance, alongside additional support to help them take steps back to work.

11.7 It is also important to ensure that parents are able to better combine work and caring responsibilities, so that they are able to work in jobs that match their skills and that those who want to work more can. This is particularly important in terms of women's labour market participation as, while progress has been made, gender inequalities in employment remain - the female employment rate now stands at 68.6%, around 10 percentage points lower than men (78.3%).[3] Much of this relates to childcare: according to the 2012-13 DfE childcare and early years survey of parents over half (54%) of non-working mothers agreed that they would like to go out to work if they could arrange good quality childcare that was convenient, reliable and affordable.[4] There is potentially a huge economic prize from enabling women to play a fuller role in the economy, where they want to. The OECD have estimated that equalising the role of men and women in the labour market could increase GDP by 10% by 2030.[5]

Chart 11.A: Qualifications and occupation skill levels, by gender



Sources: UKCES UK Skill Levels and International Competitiveness, 2013; ONS Women in the Labour Market, 2013.

[3] Office for National Statistics, labour market statistics

[4] *Childcare and Early Years Survey of Parents, 2012-13*, Department for Education, January 2014.

[5] *Effects of Reducing Gender Gaps in Education and Labour Force Participation on Economic Growth in the OECD*, Organisation for Economic Co-operation and Development, December 2012

11.8 The government already provides significant support to help parents enter and stay in work, including 15 hours of free childcare during term time for all 3 and 4 year olds and for the most disadvantaged (around 40%) of 2 year olds. From September 2017 onwards, this free entitlement will be doubled to 30 hours a week for working parents of three and four year olds, worth around £5,000 a year to parents. The government will implement this extension of free hours early in some local areas from September 2016.

11.9 To further support families, in the last parliament the right to request flexible working was extended to all. Shared parental leave was introduced from April 2015 to help parents balance the responsibilities of childcare between them. And under Universal Credit, the previous government increased support available to low-income families to cover up to 85% of childcare costs, where all parents are in work. Finally, from early 2017 Tax-Free Childcare will provide working families with 20% support on childcare costs up to £10,000 per year for each child. This means that families could receive up to £2,000 in support for each child per year.

11.10 In the context of the extensive childcare support offered to parents of 3 and 4 year olds, the government will also change the conditions for parents claiming out of work benefits. From April 2017, parents claiming Universal Credit will be expected to look for work from when their youngest child turns 3, and to prepare for work when their youngest child turns 2. In return, Jobcentre Plus will increase the support available for parents with younger children.

12 Financial services that lead the world in investing for growth

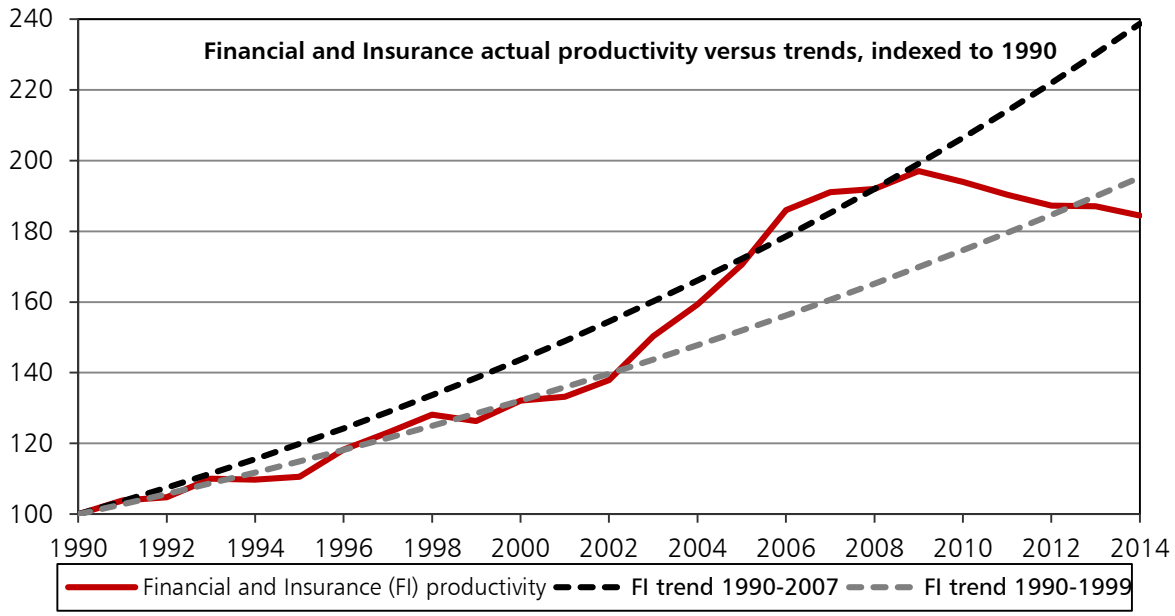
12.1 The financial services sector has a dual role in supporting UK productivity. It is critical for supporting the rest of the economy, allocating resources and facilitating long term productive investment. As a major contributor in its own right to the UK's economic success, its own productivity performance matters too.

12.2 The financial sector is a major source of comparative advantage in the UK, generating £58 billion in net exports and contributing 8.4% of GVA in 2014.[1] Among the critical issues to ensuring that the UK remains the premier global financial hub and that the UK's financial sector continues to support the UK economy are: securing the stability of the financial sector, which is necessary for sustainable growth and where enormous progress has been made over the last Parliament; ensuring a thriving financial services sector positively supports the rest of the economy by helping to allocate resources efficiently; and restoring the financial services sector to a path of positive yet sustainable productivity growth to get the economy back to its full potential.

12.3 Financial sector productivity is currently over 20% below trend growth from 1990-2007 (Chart 12.A). Strong and effective competition across financial services will incentivise firms to innovate and provide the best possible products to their customers in the most efficient way.

[1] Office for National Statistics, Balance of Payments and Gross Value Added releases

Chart 12.A: Financial services before and after the crisis



Source: HM Treasury, ONS UK GDP (O) Low Level Aggregates Q1 2015 - Month 3, June 2015; Workforce Jobs, ONS, June 2015.

Promoting the provision of finance to support productive investment

12.4 In the last Parliament, a new regulatory structure put the Bank of England at the centre of the UK's financial regulatory regime. The primary objective of the Financial Policy Committee (FPC) is to ensure financial stability, which is essential to support long-term productivity growth, while its secondary objective is to support the government's economic policy. In the FPC's 2015 remit, the Chancellor has highlighted the importance and priority that the government attaches to ensuring the supply of finance to productive investment, to competition and innovation, and to the competitiveness of the financial services industry.

12.5 To promote the provision of finance to support productive investment, it is important that it can be measured accurately. The Chancellor has therefore asked the Governor of the Bank of England, working with HM Treasury, to initiate research to create better measurement of 'finance for productive investment' covering all asset classes and all stages of finance, with a view to publishing the data on a regular basis.

12.6 The UK's vibrant capital markets have played and will continue to play a vital role in supporting productive businesses. HM Treasury, working collaboratively with partners such as the Bank of England, the Financial Conduct Authority (FCA) and other EU Member States, will:

- support actively the European Commission's overarching initiative to create a Capital Markets Union (CMU), which aims to improve access to finance for all businesses across Europe (in particular SMEs), benefitting both UK companies and the UK financial services sector
- promote the development of simple, transparent and comparable securitisation
- continue to work to remove barriers to the development of a private placements market

- support efforts to improve the Initial Public Offering (IPO) market, including reform of the Prospectus Directive
- catalyse a market-wide discussion of the costs and benefits of greater standardisation in corporate bond markets

Restoring the financial services sector to a path of positive but sustainable productivity growth

12.7 The government's vision is that five years from now UK financial services will be the best regulated in the world, with the highest standards of conduct; there will be more competition, more innovation and more choice for consumers; the UK will be the leading FinTech centre in the world; there will be more high quality jobs in finance across the UK; the City of London will remain the world's leading international financial market; and the UK will remain a highly attractive location for domiciling internationally active financial institutions.

12.8 To support the productivity of the financial services sector, the government will promote banking competition, support the FinTech sector to encourage innovation, and ensure that both regulation and taxation remain proportionate.

12.9 The government has already taken extensive action to increase banking competition, including through giving both the PRA and the FCA competition objectives; working with both regulators to lower barriers to entry for new banks; delivering the 7-day switching service and midata; creating the Payments Systems Regulator to ensure all banks can access the payments systems on fair terms; and legislating to help businesses secure finance from alternative lenders.

12.10 As a further step, the PRA and FCA have agreed to establish a joint New Bank Unit to help new, prospective banks to enter the market and to support them through the early days of full authorisation. The PRA and FCA will undertake a review of the effectiveness of the Unit after three years to ensure it is working in the best interests of new banks.

12.11 To track how the UK ranks against its international competitors, the government will launch an international FinTech benchmarking exercise in the autumn. The Chancellor has also appointed a Special Envoy for FinTech, Eileen Burbidge, to champion FinTech across the UK and at an international level.

12.12 It is vital that regulation remains proportionate and regulators support effective competition. The government intends to issue remit letters to the PRA and the FCA in order to highlight those aspects of government economic policy that are most relevant to the regulators' duties. Both regulators have a duty to have regard to the desirability of sustainable economic growth in the medium or long term. These new remit letters will outline the government's priorities for increasing competition and innovation in financial services, for ensuring that the UK remains an attractive location for financial services businesses, and for securing London's role as the leading international financial centre. The government has also asked both the PRA and FCA to publish Annual Reports on how they are delivering against their respective competition objectives across financial services, to set out clearly the steps being taken to drive more competition and innovation and to help ensure that the right incentives exist for new banks to enter the market.

12.13 The UK has a competitive tax environment for financial services. While the government maintains that banks should make an additional contribution to reflect their unique risks, it recognises the need to balance this with considerations around UK competitiveness and banks' ability to support to the broader economy. The Summer Budget 2015 therefore announced a long-term plan for the taxation of banks. The plan sets out in legislation a path towards a

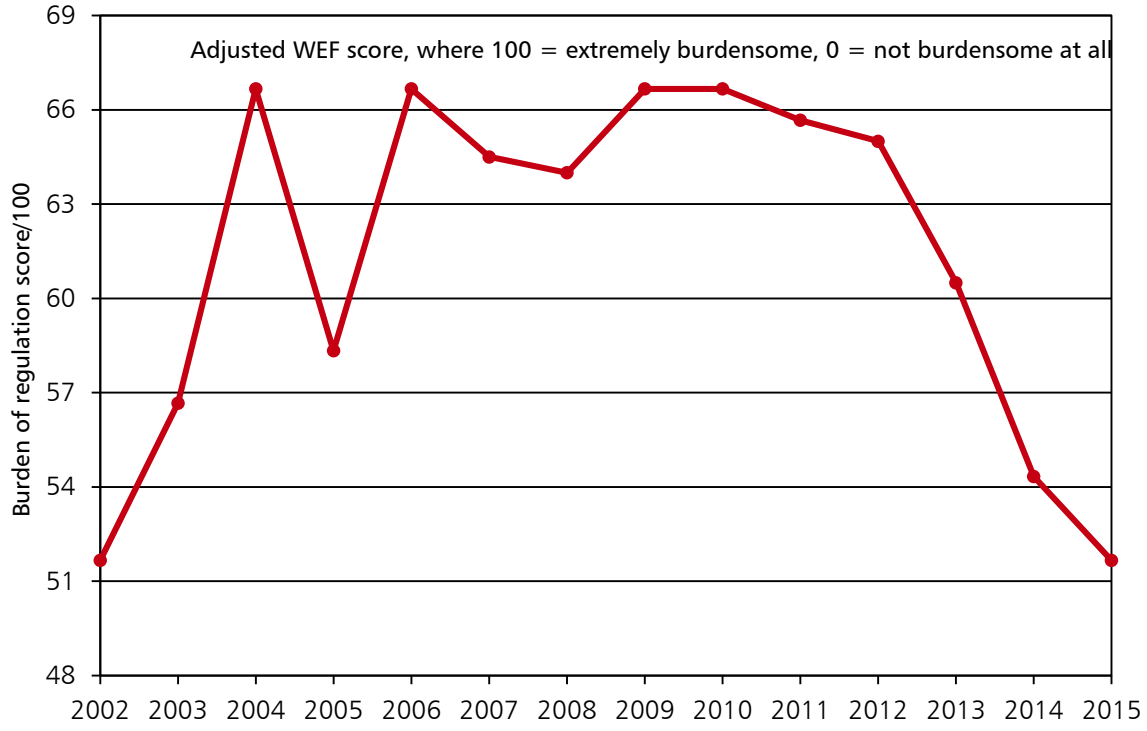
structure where banks have a 26% corporation tax rate – the lowest rate among G7 nations – and a 0.10% levy on their UK balance sheet liabilities, less than half the current rate, and ending the imposition of the levy on non-UK liabilities with effect from 2020-21.

12.14 The financial services sector is well placed to lead the way on issues that matter across the economy. To expand female representation in senior leadership positions, Jayne-Anne Gadhia, CEO of Virgin Money has agreed to lead a review into representation of women in senior managerial roles in the financial services industry.

13 Open and competitive markets with the minimum of regulation

13.1 Competitive markets are fundamental to fostering productivity growth. They compel firms to be more efficient and innovative, allow new businesses to enter markets and ensure that the best firms grow. A regulatory environment that encourages innovation by allowing new competitors to enter and expand into markets is a key part of this – for example, in the decade to 2002, opening up the market to new providers of international telephone calls led to a decrease in prices of up to 90%.[1] And simplification of regulatory requirements – or deregulation – can free-up resources for businesses to put to more productive uses, raising long-run productivity and growth.

Chart 13.A: Perceptions of the UK regulatory burden[a]



Source: WEF Global Competitiveness Report 2014-15

[a] WEF question: In your country, how burdensome is it for businesses to comply with governmental administrative requirements, e.g. permits, regulations, reporting? (1=extremely burdensome, 7= not burdensome at all) (HMT analysis to adjust to score/100)

13.2 The UK's competition framework is a clear strength - research suggests that improvements in competition policy may have accounted for 20% of industry productivity growth in the UK in the decade to 2005.[2] This active development of competition policy is a huge advance from the

[1] *The Benefits from Competition: Some illustrative UK cases*, Department of Trade and Industry, Economics Paper NO.9, July 2004

[2] *Factsheet on how competition policy affects macro-economic outcomes*, OECD, October 2014

feather-bedding of national champions that was identified as a major contributor to the UK's weak economic performance in the 1950s and 1960s.[3]

13.3 To maintain and develop this strength, the government's priorities are; maintaining a strong, independent competition regime, to effectively tackle competition problems; ensuring consumer choice can drive competitive forces which will reward productivity; and ensuring the UK stays at the forefront of regulatory excellence and that its regulatory frameworks allow new and innovative firms and business models to start up and grow.

Greater competition in markets

13.4 During the last Parliament, the government created the independent Competition and Markets Authority, bringing existing competition authorities into a more streamlined body and modernising the competition toolkit. The government's role is to ensure that the regime continues to be amongst the best in the world. To do this it will consult on a new Strategic Steer to the Competition and Markets Authority, which includes an increased focus on productivity and a commitment to innovation and encouraging new entrants, and will review Trading Standards to ensure that consumer enforcement capability effectively supports competition and better regulation objectives.

Active consumers

13.5 Active consumers can play a key role in pushing firms to compete more and offer greater choice. One of the ways consumers can exert their influence is to switch suppliers. The government will introduce and act on principles for consumer switching so that consumers can switch quickly and reliably and have access to their own data in a way that helps them exercise choice. The government intends to launch a call for evidence on how to implement the principles for consumer switching over the summer. As well as the action on energy markets (see paragraph 6.4 above), the government will legislate to support quick and easy switching in communications markets**.** Easy switching is important in the fast moving communications markets, particularly with the development of bundled services.

Regulatory frameworks that support disruptive business models, innovation, emerging technologies and the digital economy

13.6 The spread of high speed communications infrastructure is driving forward the development of new business models and disruptive technologies. These businesses are shaking up markets, creating competition and generating more choice. The government wants to ensure that the UK is supporting these businesses, breaking down barriers and boosting UK productivity. To do this the UK's regulation and enforcement frameworks must be able to adapt more effectively to rapidly changing technologies. The government will therefore require departments to work with regulators to publish Innovation Plans by spring 2016. These will set out how legislation and enforcement frameworks could adapt to emerging technologies and disruptive business models.

13.7 The success of the sharing economy demonstrates how new technology can drive industry transformation, new markets and greater competition. The sharing economy is already worth over £500 million in the UK and could be worth up to £9 billion a year by 2025.[4] In order to unlock the potential of this sector, the government will build on the measures announced at March Budget 2015 and will launch an Emerging Industry Action Group for the sharing

[3] *British relative economic decline revisited: The role of competition. Explorations in Economic History*, Crafts, N., 2012

[4] *Five key sharing economy sectors could generate £9 billion of UK revenues by 2025*, PWC, August 2014

economy, to ensure continued engagement with the industry to identify and act on barriers to business expansion.

13.8 The UK's digital economy is vibrant and growing rapidly. To ensure that these benefits are felt throughout the whole economy the government will publish a Digital Transformation Plan by autumn 2015 that sets out concrete actions the government will take to support the adoption of digital technologies across the economy, and the ways in which the government will assist in tackling barriers to new businesses entering and creating new markets.

13.9 The government welcomes the EU Digital Single Market (DSM) initiative, launched by the European Commission in May. The creation of a DSM will support investment in digital infrastructure, provide opportunities for companies to grow and innovate and benefit consumers through increased access to a wider range of digital products and services. The potential gains of a fully functioning DSM are estimated to amount to around 0.5% of EU GDP, perhaps significantly more.[5] The UK in particular stands to gain given its leading position in e-commerce and the tech sector. Over the next 18 months the Commission will be making detailed proposals on the each of the 16 initiatives proposed in the strategy.

Cutting red tape

13.10 In the last Parliament, the government embarked on an ambitious deregulatory agenda through flagship programmes such as One-In-Two-Out and the Red Tape Challenge, cutting the net burden of regulation by £2.2 billion per annum.[6] Building on this, the government has committed to cut at least a further £10 billion of red tape on business. The Better Regulation Executive will launch the Cutting Red Tape programme to help deliver this ambitious target, working in partnership with industry to identify and address red tape resulting from legislation and enforcement activities in sectors. The government will launch reviews across: enhancing the effectiveness of the Anti-Money Laundering and Terrorist Financing regime, Energy, Mineral Extraction, Agriculture, Waste and Care Homes. The government also recognises that regulators' actions need to minimise unnecessary burdens on business. The government will therefore legislate through the Enterprise Bill to extend the government's target for cutting red tape to cover the activities of regulators.

13.11 In parallel, the government will continue to support the better regulation agenda at EU level. The government welcomes the European Commission's Better Regulation package in offering the opportunity for the EU to improve the way it regulates and makes policy.

Championing enterprise

13.12 Economies stagnate without a dynamic and enterprising firm culture. Entrepreneurs can be vital sources of competition and disruptive innovation, driving productivity by ensuring that firms continually strive to improve their efficiency and better meet customers' needs.

13.13 Enterprise is not just about the number of start-ups. In fact, most new businesses are no more productive than existing businesses, even after 5 years.[7] Raising the productivity of the whole economy depends on facilitating the growth of new and existing businesses with the greatest potential. But this is a relatively select group: typically, over a three year period, less

[5] The Cost of Non-Europe in the Single Market – III – Digital Single Market, European Parliament, September 2014 suggests an increase in EU GDP of 0.4% in 2020 (equivalent to €60 billion in 2014 prices); The Economic Impact of a European Digital Single Market, Copenhagen Economics, March 2010 puts the estimate at around 4% of EU GDP.

[6] *One-in, two-out: ninth statement of new regulations*, Department for Business, Innovation and Skills, December 2014.

[7] *The Other Productivity Puzzle*, Nesta, October 2014.

than 1% of small and medium sized businesses will achieve high growth, although that same group will generate 20% of all job growth amongst established firms which grow.[8]

13.14 The priorities are to make sure that it is easy to start a business, that the best new businesses can scale up rapidly, and that they can fulfil their long term potential. This requires:

- access to finance, which is essential for many would-be entrepreneurs to launch a new venture, and for small businesses with growth potential to scale up. Credit conditions for smaller businesses have improved over 2014-15, but remain challenging, and the market in equity finance could also work better
- building a stronger enterprise culture and improving management skills. The UK has a thriving entrepreneurial culture relative to the rest of Europe, but lags behind the US.[9] In particular, many businesses recognise that their management and leadership capabilities need to improve. According to some academics, one quarter of the productivity gap between the UK and the US is associated with such capabilities[10]

13.15 Since 2010, the government has increased banking competition and set up the British Business Bank, expanded tax reliefs and cut regulation for smaller businesses, simplified business support through the Business Growth Service, and strengthened the prompt payment code. The UK had a record 5.2 million private sector businesses at the start of 2014, an increase of 760,000 compared with start of 2010.[11] But the government wants the UK to be a place where doing business is even easier. To achieve this aim, the government will develop and retain the best enterprising talent, and will build on the UK's already strong position, ranked 8th worldwide and 3rd in Europe, aiming to be number 1 in Europe and in the top 5 worldwide.[12]

13.16 The government funds advice and support to develop management capability in SMEs and will explore options for devolving responsibility for designing and delivering this to local areas as part of city devolution. Evidence suggests that bespoke, in-work development is most effective among small business owners and managers,[13] and it follows that locally delivered schemes are more likely to be able to facilitate this kind of tailored support cost-effectively.

13.17 To support wider improvement in the management capabilities that underpin the ability of firms to make the best use of skills, to adopt new technology and to innovate and grow, **the government is announcing plans to introduce a new employer-designed degree apprenticeship in Leadership and Management to boost the capabilities of future business leaders** and **proposes that new income contingent loans for postgraduate taught masters students are also made available to contribute to the costs of an MBA**. Following consultation, the government will set out details on how these loans will be delivered later this year.

[8] *ERC Insight: Contribution to job creation by high growth SMEs*, Enterprise Research Centre, 2015.

[9] *UK 2014 Report*, Global Entrepreneurship Monitor, 2015.

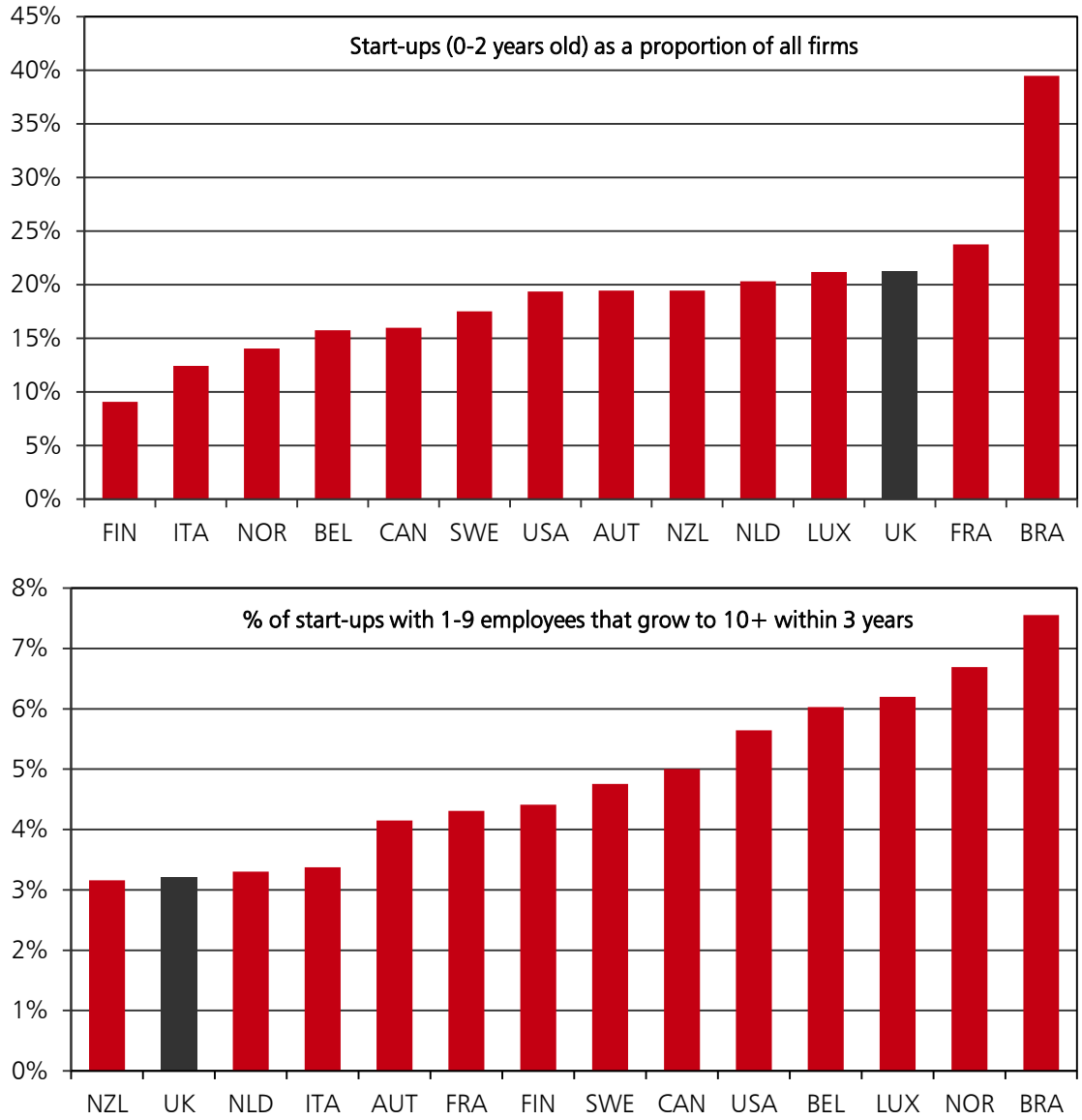
[10] *Management as a Technology*, Nicholas Bloom, Raffaella Sadun and John Van Reenen, 2015 (public draft).

[11] *Business Population Estimates for the UK and Regions 2014,* Department for Business, Innovation and Skills, November 2014.

[12] *Doing Business Rankings*, World Bank, 2014.

[13] *Supporting Sustained Growth Among SMEs*, Stephen Roper and Mark Hart, 2013; 'Towards 'Leaderful' Communities in the North of England', Richard Thorpe et al, 2008.

Chart 13.B: The UK does well on start-ups, but is less effective at growing them



Source: Organisation for Economic Co-Operation and Development; 'The Dynamics of Employment Growth: New Evidence from 18 Countries', Chiara Criscuolo, Peter N. Gal and Carlo Menon (OECD), 2014.

13.18 The plan also reconfirms the government's intention to help new and existing challenger banks to inject fresh competition in the market, including through the British Business Bank. The Business Bank is increasing the supply of debt and equity finance available to smaller businesses, including start-ups, as well as diversifying the market to give a greater choice of options and providers. The Business Bank aims to facilitate up to £10 billion of finance by 2019, the majority of which will be through providers other than the big 4 banks.

14 A trading nation open to international investment

14.1 The UK has benefited hugely from its openness to the world. Exports matter, both to earn money to pay for imports, and because they help rebalance the economy. But the economic benefits of trade go much further. Trade increases UK productivity by allowing firms to specialise in sectors in which the UK has a comparative advantage, and through exposure to new ideas and international competition. Imports also provide cheaper inputs for our own goods and services, as well as lower prices and more variety for consumers. Inward investment is something the UK has excelled at, particularly in recent years (with the FDI stock reaching £1 trillion this year) and is hugely important, as is outward investment.[1]

14.2 Among the critical issues are:

- improving export performance, especially to emerging markets. Historically the UK has under-exported to emerging markets compared with major competitors. This has begun to change, with exports to emerging markets increasing faster than the average in the last decade. But even now, exports to China, the world's second largest economy, are only just over one-third of those to Germany.[2] Getting the UK's existing exporters to diversify into more markets is a key challenge
- further integration of international service sector markets. The UK is one of the world's leading exporters of services, second only to the US in 2013,[3] and could benefit hugely from a more integrated market for services. Within the EU, estimates suggest the single market has increased EU GDP by around 2% to 5%,[4] and full liberalisation of the single market in goods and services could increase EU GDP by 14% and UK GDP by 7%[5]
- supporting trade agreements beyond the EU. The European Commission estimates that completing all current trade talks could add a further 2.2% or €275 billion to EU GDP,[6] while estimates by the Centre for Economic Policy Research suggest an EU-US FTA could boost the UK economy by up to £10 billion annually in the years following a deal[7]

[1] *UKTI Inward Investment Report 2014/15*, UK Trade & Investment, 2015.

[2] *Pink Book, exports of goods and services*, Office for National Statistics, 2014.

[3] OECD Balance of Payments database (MEI), Organisation for Economic Co-operation and Development, 2015.

[4] *Steps towards a deeper economic integration: the Internal Market in the 21st Century*, Ilzkovitz, F., et al., 2007; *The Economic Impact of European Integration*, Boltho, A. & B. Eichengreen, 2008.

[5] *The economic consequences for the UK and the EU of completing the Single Market*, Aussilloux, V., et al., Department for Business Innovation & Skills Economics Paper No. 11, February 2011

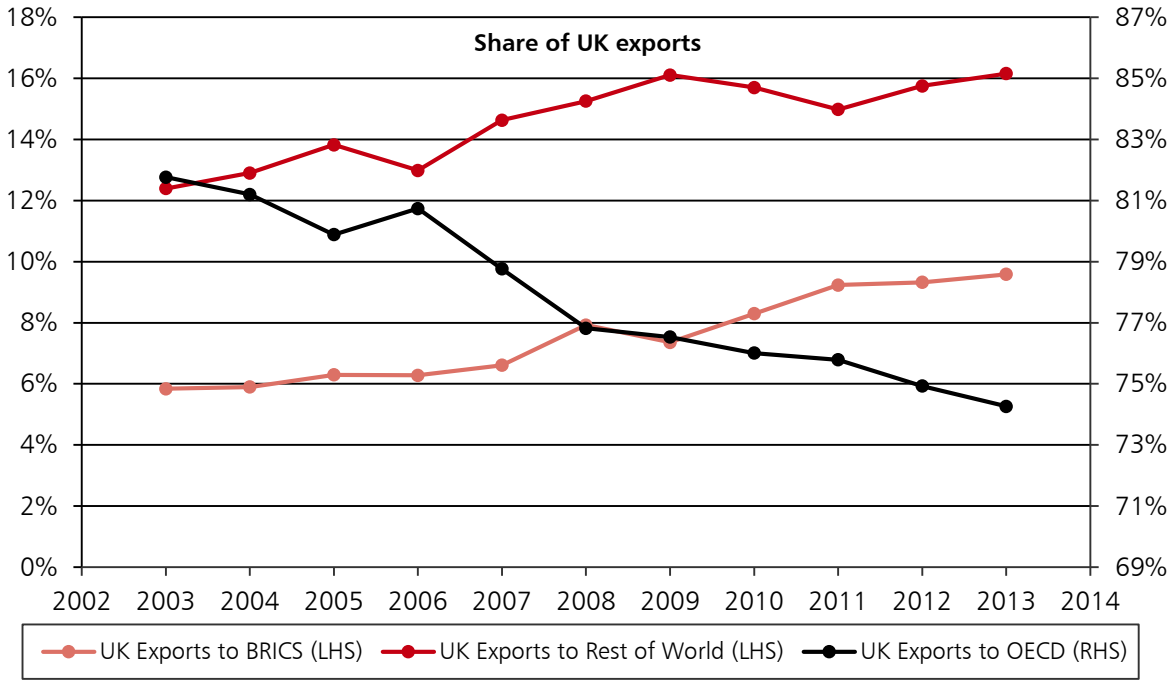
[6] *The EU's bilateral trade and investment agreements:* where are we?, European Commission Memo, 2013

[7] *Estimating the economic impact on the UK of a Transatlantic Trade and Investment Partnership Agreement between the European Union and the United States*, Centre for Economic Policy Research, 2013

£1 trillion of exports by 2020 and 100,000 more companies exporting

14.3 UKTI has more than doubled the number of businesses it helps on an annual basis since 2010, supported by extra resources.[8] Given the scale of the export challenge it is essential that the broad range of relevant government activity works effectively for all companies across multiple sectors and markets. The government will conduct an internal review of expenditure across departments that supports the government's prosperity objectives. The review will report in time to inform the next Spending Review and the Strategic Defence and Security Review.

Chart 14.A: UK Export share to advanced and emerging economies as a % of total



Source: HM Treasury calculations from ONS The Pink Book 2014, Part 3: Geographical Breakdown.

14.4 The government will remodel its delivery on trade, exports, investment and prosperity. In the past, too much of the burden of promoting exports has fallen within government on UK Trade and Investment and UK Export Finance. The government will now mobilise the whole of government behind exporting, enhancing and modernising government support. A cross-Whitehall Implementation Taskforce has been established, reporting to Cabinet.

14.5 It is important that the government continues to boost exports to fast-growing emerging markets. Goods exports to China totalled £14.1 billion in 2014, an increase of 68% since 2010.[9] The government will continue this progress by enhancing the UK's relationship with key emerging markets, including by: tackling regulatory and other barriers to trade and economic growth; continuing to double support to UK firms in China; and identifying and creating opportunities for UK firms in markets like China, India and Brazil including by using the annual Economic and Financial Dialogues' focus on financial services and infrastructure.

14.6 Export finance is also a vital component of government support to exports. UK Export Finance is exploring further ways to increase its product range. The government expects to invite

[8] UK Trade & Investment, PIMS Database

[9] UK Trade data, Office for National Statistics, April 2015

banks, as from next month, to submit applications for working capital support to UK exporters' suppliers. The British Business Bank will work with UK Export Finance to review the access to finance challenges facing SMEs looking to export to ensure that government support best addresses their needs.

14.7 It is also the case that many Low Income Countries are growing faster than the emerging market average, and the government believes they should have access to the best international expertise, including from UK companies, to meet their development objectives. The government will therefore consult on opportunities through increased export finance to improve competition to solve development problems in Low Income Countries, including a potential Concessional Export Credit Facility. It is anticipated that UK company exports would be part of the solution.

14.8 The government is firmly committed to ensuring that the UK remains the world's leading financial centre. In March 2013, the government launched the Financial Services Trade and Investment Board (FSTIB) to ensure that government departments and industry work in close partnership to promote trade and investment in priority markets, such as China, India and Brazil, and priority sectors, such as Islamic Finance, FinTech, insurance and reinsurance and investment management. The FSTIB has successfully delivered on these objectives, and the government is re-launching the Board with new industry external members and a renewed mandate to identify and actively lead on key opportunities to support the industry to trade, attract inward investment and remain globally competitive.

Trade liberalisation

14.9 Recent years have seen a World Trade Organisation (WTO) agreement on trade facilitation in 2013, and agreement of the EU Canada Comprehensive Economic and Trade Agreement in 2014. The government will pursue further trade liberalisation, working to conclude key trade agreements where negotiations are already underway (such as the EU-US Free Trade Agreement), and to initiate negotiations with key trading partners where they are not.

Single EU market in goods and services

14.10 The government will work to secure agreement to reforms that will complete the single market in goods and services, and welcomes recent European Commission initiatives in respect of Capital Markets Union, Energy Union, and the Digital Single Market.

15 Resurgent cities, a rebalanced economy and a thriving Northern Powerhouse

15.1 A dynamic economy needs thriving cities that can expand and adapt to meet the challenges of the 21st century. Cities attract high value firms and skilled workers, and, in turn, they help to boost the productivity of those that locate there. They provide deep markets for labour, vibrant competition between firms, and enable the rapid diffusion of new ideas. Their success also matters because cities and their surrounding areas are home to three-quarters of the UK's population and even more of the nation's jobs.[1]

15.2 London is one of the world's greatest global cities and a huge asset for the national economy. However, in recent decades the UK has relied too heavily on the capital to generate growth.[2] Economic power is more evenly spread across the country in economies like Germany and the US. In 2010, London accounted for 28% of UK GDP, whilst Berlin and New York accounted for much smaller shares, at 5% and 7% of their respective national GDP.[3] The UK's continued national prosperity depends on cities outside the capital doing better.

15.3 To rebalance the economy, cities need effective governance. OECD research has shown that cities around the world with fragmented governance structures have up to 6% lower levels of productivity than those that do not.[4] England currently has 353 local authorities with over 18,000 elected members.[5] This can lead to fragmented decision making and blurred accountability; even within the same city region, urban and suburban leaders do not always work together on shared objectives. The experience of London and other major international cities suggests that a directly elected mayor can cut through these difficulties. The government has therefore been clear that devolution of significant powers will rest on cities agreeing to rationalise governance and put in place a mayor to inspire confidence.

15.4 Cities also need long-term investment in effective transport links. It is currently quicker to travel the 283 miles from London to Paris by train than it is to travel less than half that distance between Liverpool and Hull.[6] Excellent connectivity will bring cities closer together to help create the critical mass to compete globally. Better connections between economic centres allow clusters to develop even where companies are located apart, supporting more trade, more interactions between businesses and the generation of more products and ideas.

[1] *Unlocking growth in cities*, HM Government, December 2011

[2] ONS Regional Gross Value Added (Income Approach), December 2014. London and the South East have accounted for half of all Gross Value Added (GVA) growth since 2010, whilst London alone has accounted for over a quarter of all GVA growth since 1997.

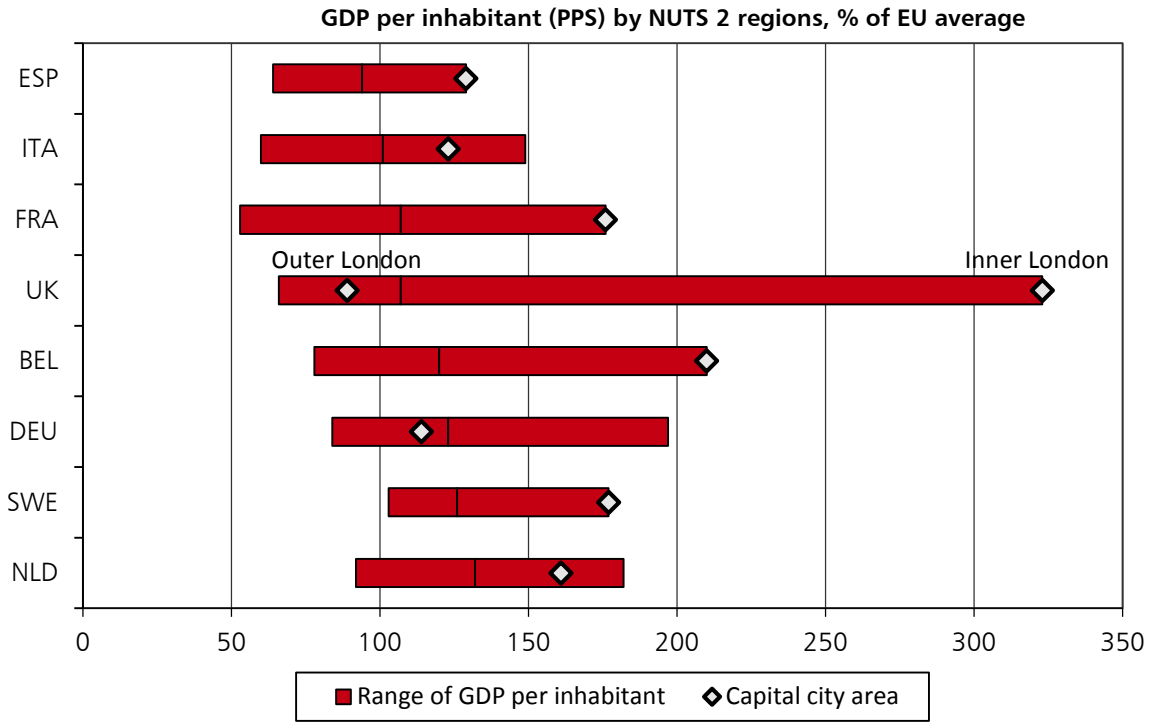
[3] *Metropolitan eXplorer*, Organisation for Economic Co-operation and Development, October 2013

[4] *What makes cities more productive? Evidence on the role of urban governance from five OECD countries*, Organisation for Economic Co-operation and Development, 2014

[5] *Local Government Finance Statistics England No.24 2014*, Department for Communities and Local Government, June 2014'

[6] *Northern Powerhouse: One Agenda, One Economy, One North*, Transport for the North Partnership Board, March 2015

Chart 15.A: GDP per person as % of EU average[a]



Source: Eurostat online database.

[a]NUTS 2 divides the EU into areas with populations between 800,000 and 3 million

15.5 Finally, cities need the right support to build their human capital and generate innovation. The gap in labour productivity between the UK's two largest city economies, London and Manchester, is larger than in any other G7 country and more than double that in both Germany and Japan.[7] Reform of the skills system is necessary to provide cities with the skilled labour businesses need and innovation policy needs to support the development and diffusion of ideas.

15.6 Successful rebalancing will not be achieved by pulling down the capital city, but by building up the Northern Powerhouse and creating strong city regions, led by powerful, democratically elected mayors, that benefit from investment in world-class transport and have the support they need to foster innovation.

[7] *Metropolitan eXplorer*, Organisation for Economic Co-operation and Development, October 2013

World class governance

Box 15.A: Greater Manchester Devolution Deal

The government is committed to giving cities the opportunity to drive growth within their metro areas. That is why, on 3rd November 2014, the Chancellor and Greater Manchester civic leaders signed a ground-breaking agreement for Greater Manchester to create the first directly elected metro-wide mayor outside of London, with powers over transport, housing, planning and policing.

Following the initial deal, Greater Manchester and NHS England signed up to arrangements to bring together £6 billion of NHS and social care budgets so that joint planning of these services can deliver better care for patients.

In addition, the March Budget 2015 announced a pilot scheme in Greater Manchester and Cheshire East to enable the retention of 100% of any additional business rate growth.

15.7 Just as strong local leadership is what made cities successful in the past, it also has the potential to transform competitiveness in the present. The government wants to build on the success of the deal with Greater Manchester, to give more cities the freedom and powers to enable investment and make decisions in the best interest of their metro area. That is why the government has invited major cities to come forward with proposals to elect a mayor and take greater control and responsibility over all the key things that make a city work, from transport to housing to skills, and key public services like health and social care. By the end of this Parliament, a regional network of cities, working together to take responsibility for their own prosperity, will underpin a thriving Northern Powerhouse and growth across all of the country's regions.

15.8 Building on the ground-breaking devolution deal agreed in November 2014, the government is making further progress in devolving powers to Greater Manchester. This includes putting Fire Services under the control of the new directly-elected mayor, establishing a Greater Manchester Land Commission, granting the city region more powers over planning (subject to the agreement of the Cabinet member representing the district in which the power is used), and further discussion of collaboration on children's services and employment programmes. The government will also consult on devolving powers on Sunday trading to city mayors and local authorities. This will look at allowing mayors and local authorities to extend Sunday trading for additional hours within parameters that they would determine.

15.9 To fulfil the government's commitment to rebalancing the economy and further strengthening the Northern Powerhouse, Summer Budget 2015 also announced that the government is working towards further devolution deals with the Sheffield City Region, Liverpool City Region and Leeds, West Yorkshire and partner authorities, to be agreed in parallel to the Spending Review. If agreement is reached, including on an elected mayor working with local leaders to oversee new powers devolved from ministers, these city regions will be granted significant additional powers and the opportunity to take control of their own affairs to support economic growth.

15.10 The government also remains open to any further proposals from local areas for devolution of significant powers in return for a mayor, in time for conclusion ahead of the Spending Review.

Widespread transport devolution

15.11 Cities require high-quality transport if they are to be successful, as well as the powers to deliver a fully integrated public transport system that truly serves the needs of their residents and businesses. The government also recognises that transport plays a vital role outside major city regions in meeting the needs of local communities as well as driving economic growth. The government is committed to significant transport devolution in all of the country's city regions that elect a mayor. This includes the roll-out of Oyster-style smart and integrated ticketing systems that will provide people with quicker and easier door-to-door journeys, greater choice, as well as simpler and more flexible fares.

15.12 Building on the government's commitments set out in Chapter 5 to improve transport connections throughout the country, the government is launching an ambitious new transport devolution package for the North to take the Northern Powerhouse to the next stage and create a single northern economy that is genuinely stronger than the sum of its parts. Building on the Northern Transport Strategy that was jointly published by the government and Transport for the North (TfN) earlier this year, the government is now committing to:

- devolving far reaching powers over transport to the North's mayor-led city regions to deliver fully integrated public transport systems, supported by Oyster-style smart and integrated ticketing systems
- establishing TfN as a statutory body with statutory duties to set out its transport policies and investment priorities in a long-term transport strategy for the North, underpinned by £30 million of additional funding over three years to support TfN's running costs and enable them to advance their work programme
- appointing by the autumn an interim Chief Executive and executive team for TfN to accelerate TfN's work programme, and appointing a Chair by the end of the year, with an update on the Northern Transport Strategy to be published by Budget 2016
- working with TfN to advance the introduction of Oyster-style smart and integrated ticketing systems across bus, tram, metro and rail services throughout the region, making this one of the top priorities for TfN's newly accelerated work programme
- working with TfN to push forward plans to transform east-west rail and road connections via TransNorth and options for a new TransPennine Tunnel, with a prioritised list of scheme options to be produced by Budget 2016, and an interim report in time for the Spending Review

Empowering local leaders to drive growth, through skills, science and innovation

15.13 Cities need a deep pool of human capital to attract investment and develop knowledge-intensive clusters. As set out in chapter 3, the government will ensure cities take a leading role in developing the skills they need, including inviting local areas to participate in the restructuring and commissioning of professional and technical provision, including the ability to invite colleges to become specialist Institutes of Technology.

15.14 The development and diffusion of ideas is a vital component of cities' productivity advantage. To support this:

- the government will invite universities, LEPs, businesses and cities to work with the government to map research and innovation strengths and identify potential areas

of strategic focus for different regions through a series of science and innovation audits

- the government will encourage universities to strengthen local collaboration, to be recognised through funding stream such as the Research Partnership Investment Fund, building on successful models such as the N8, the M6 and W4
- flexible land markets are central to harnessing the productivity benefits that cities can offer. A more flexible, responsive planning system will enable people to afford to live and work in successful cities, allow firms to expand and urban economies to adapt to new opportunities. The reforms set out in chapter 9 will help improve the planning system in all cities and city-regions. Planning powers can be an important component of devolution arrangements, as has been the case with Greater Manchester and London

15.15 The government is inviting Local Enterprise Partnerships to bring forward bids for a new round of Enterprise Zones. They will be able to work with DCLG to develop their business cases, and only proposals with strong economic potential will be awarded Enterprise Zone status.

Rebalancing growth

Midlands – Engine for Growth

15.16 The government is committed to driving economic growth throughout all of the country's regions and is strongly supportive of the steps taken in the Midlands to develop a pan-regional approach to transport.

15.17 The local transport authorities across the East and West Midlands have come together through the voluntary partnership, Midlands Connect, to develop their collective vision for transforming the region's transport connectivity and driving economic growth. The government is therefore committing to providing £5 million of funding to the Midlands Connect partnership to further develop a transport strategy for the Midlands.

15.18 In the Long Term Economic Plan for the Midlands, the Chancellor committed to working with the Midlands LEPs to support a regional approach to skills. The government will work with LEPs, the local partners and the emerging combined authorities to scale up this work across the Midlands, looking to agree a clear and detailed delivery plan in autumn 2015.

15.19 The government supports the extension of the Birmingham Enterprise Zone, which will support Birmingham to build on the government's investment in HS2 to generate further benefits for the city of Birmingham, and will consider a business case as part of the Spending Review.

15.20 The government also strongly supports the recent publication of a West Midlands Statement of Intent for devolution, which sets out ambitious proposals for a strong and coherent West Midlands combined authority. The government is also pleased to have received two Combined Authority proposals from local authorities in the East Midlands.

Supporting the rural economy

15.21 While cities are the driving force of the economy, it is important that all areas of the economy contribute to, and benefit from, productivity growth. That is why the Secretary of State for Environment, Food and Rural Affairs will launch a new '10 Point Plan' for rural productivity. This will set out the government's ambitions to:

- enable communities to allocate land for Starter Homes developments, including through neighbourhood plans
- as part of the new bidding round, encourage towns and districts within rural areas to work with LEPs on producing bids to become an Enterprise Zone, so that rural areas can also benefit from the new programme
- review the current threshold for agricultural buildings to convert to residential, to further support delivery of new homes in rural areas
- extend permitted development rights to taller mobile masts, in order to support improved mobile connectivity in rural areas; a call for evidence on these proposals has been issued today
- complete the superfast broadband programme on time and on budget, ensuring 95% of the UK has access to superfast by 2017

Rebalancing growth across all regions and nations of the UK

15.22 In Scotland, Wales and Northern Ireland, many of the levers available to promote and support productivity, economic recovery and growth are devolved responsibilities of the Scottish Government, Welsh Government and Northern Ireland Executive. For example, the devolved administrations are responsible for local government, including its structure and financing, housing, regeneration and the planning framework.

15.23 The government wants increasing productivity across all regions of the UK. Where responsibilities are retained at the UK level, the government will continue to deliver for the whole of the UK, ensuring the benefits of the union are felt in every part of the country, including:

- signing an ambitious city deal for Glasgow and the Clyde Valley in 2014. Going further, March Budget 2015 announced that the government would work with local partners and the Scottish and Welsh Governments towards City Deals for Cardiff, Aberdeen and Inverness
- supporting key infrastructure projects in Wales, funding the upgrade of the Swansea-London mainline, and paying almost half of an estimated £500 million to electrify the Valley lines
- devolving Corporation Tax rate-setting powers in Northern Ireland to address the common objective of the government and the Northern Ireland Executive to rebalance the Northern Ireland economy and drive faster economic growth

16 Public Sector Productivity

16.1 Public services represent around 20% of the economy, and so improving their productivity and efficiency will have major benefits for the economy, taxpayers, and those who use these services.[1]

16.2 Between 1997 and 2010 the Office for National Statistics (ONS) estimates that public sector productivity – measured as the amount of output produced for each unit of input, adjusted for service quality – was broadly flat. In the subsequent two years, they estimate that productivity increased by 2.5% and 1.2% respectively, as service outputs increased during that period, despite reduced budgets. This was driven largely by positive improvements in the NHS and education.[2]

16.3 Over the last Parliament the government also became more efficient, reducing the cost of inputs to protect frontline services. By the end of the current financial year government departments' administration budgets will have been reduced by 40% compared to 2010. This was enabled by a range of initiatives to reduce 'back office' expenditure, for instance the government's moves to consolidate its office estate mean that the government estate is now more efficient on average than private sector comparators.[3] The government also increased the use of digital technology in key public services, such as tax returns and voter registration, to reduce transaction costs and improve service quality.

16.4 Since 2010 many public services have improved their performance. Crime has fallen, despite reduced spending on the police,[4] and the proportion of officers in frontline roles has increased to over 90%.[5] In education, 1 million more pupils are in good or outstanding schools.[6] In the family courts, the time taken to make the important decision on whether a child should be taken into care has been halved since 2011 – now at 29 weeks instead of 56.[7]

16.5 In order to meet the fiscal challenge, the government will need to build on this success and introduce further reforms to ensure that services can meet continued - or in some cases increasing - demand at a time of reducing budgets. The government will do this through the introduction of new Single Departmental Plans, which will identify key priorities for every department, and will act as a vehicle to link inputs to outputs. The Spending Review will outline specific initiatives, based on the following principles:

- service redesign: shifting delivery to the local level, to put the public at the heart of service delivery; integrating front line services; and promoting early intervention to unlock savings
- organisation and workforce: promoting the use of shared services across government; spreading best practice; and improving leadership and capability

[1] *General Government consumption as a share of nominal GDP*, OBR, 2015
[2] *Public Service Productivity Estimates: Total Public Services*, ONS, 2015
[3] Cabinet Office benchmarking on office space, against the private sector *State of the Estate*, 2015
[4] *Crime Survey for England and Wales – year ending September 2014*, ONS, 2015
[5] *Policing in Austerity*, Her Majesty's Inspectorate and Constabulary, 2014
[6] Ofsted data, http://dataview.ofsted.gov.uk
[7] *Family court statistics quarterly: January to March 2015*, MoJ statistics bulletin, 2015

- technology and data: increasing the use of digital technology and data sharing across government to enable services to reduce costs and increase outputs

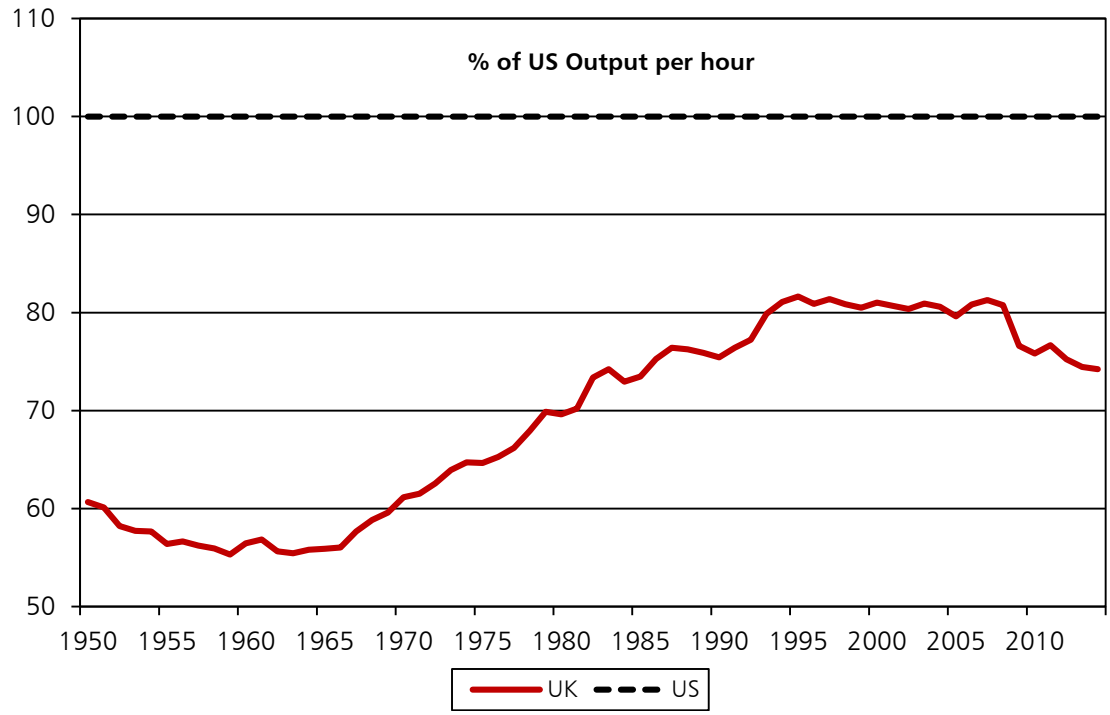
16.6 By March 2017 the government will also implement a new commercially-driven approach to land and property management across the central government estate. A new body or bodies will be created which will charge departments market-level rents for relevant freehold assets. This will drive efficiencies and the release of land and property for productive use, including for new homes. The government will now appoint a shadow Chair to lead the development and implementation of this transformation programme.

A Annex A

Historical performance

A.1 UK productivity has increased more than seven-fold over the past 100 years, with huge benefits to wages, to living standards and to the goods and services people can enjoy.[1] The UK's productivity growth has been uneven and relative performance has fluctuated, reflecting domestic policy choices as well as external factors (Chart A.1).

Chart A.1: UK productivity relative to the United States



Source: The Conference Board online Total Economy Database.[2]

A.2 At around the turn of the twentieth century, the UK lost its position as world productivity leader, as the US benefited from its growing internal market and easy land availability. In the inter-war period the UK fell further behind, partly due to policy choices that reduced competitive pressures by encouraging collusive behaviour and restricting international trade. After the Second World War, the UK experienced the fastest growth in its history but European peers did much better: this was an era of missed opportunity, a failure to take full advantage of the huge scope for catch up with the US. Again, policy is likely to have dampened productivity growth by

[1] Output per hour; *Three Centuries of Data*. Bank of England, 2015

[2] The Conference Board is an independent research association based in the US. Users should be aware that the conference board data are not equivalent to ONS data earlier in the document.

protecting firms from failure, often through nationalisation, and failing to tackle a dysfunctional relationship between trade unions and business.[3]

A.3 The UK's performance improved, first relative to the US, and then from the mid-1970s onwards, compared to other advanced economies. The UK began to catch up with leading European economies and to converge with the US. Policies helped to inject competitive intensity into the UK economy, by integrating with the Single European Market, strengthening competition policy and reforming industrial relations.[4]

A.4 Despite the improvement, a gap with the US, France and Germany remained at the onset of the financial crisis and this has grown. International comparisons of productivity are sensitive to the exchange rates used, but most plausible methods show a large gap between the UK and the most productive countries. The ONS estimate that UK output per hour is 17% below the G7 average, 27% below France, 28% below Germany and 31% below the US.[5] Matching the productivity of the US would raise GDP by 31%, equating to over £21,000 per annum for every household in the UK.[6]

A.5 There are likely to be a number of reasons for the UK's lower levels of productivity and it is difficult to identify the precise role that each of these factors plays. Lower levels of investment are likely to contribute to the gap with France and Germany, particularly in regards to R&D. Other relevant factors include skill levels and, in the case of France, the exclusion of low-productivity workers from the labour market. The gap with the US is explained less by differences in inputs, and is likely to be a combination of factors including more rapid diffusion of new innovation, stronger competition, economies of scale stemming from larger market size and superior management practices.[7]

A.6 The task of raising productivity is shared by all countries, with particular challenges and opportunities for Europe. European-level rules and agreements affect a range of policy areas, from energy to financial services, as well as influencing the terms on which British businesses can access markets in the EU and beyond.

The productivity puzzle

A.7 In recent years, a significant shortfall has opened up between the UK's actual productivity performance and the level implied by the pre-crisis trend. The productivity slowdown is an international phenomenon, experienced by the vast majority of advanced economies following the severe and enduring impact of the 2008 financial crisis: G7 annual productivity growth has slowed from 1.9 % between 1997 and 2007 to 0.9 % since the crisis.[8]

A.8 The causes of the global productivity slowdown have been widely debated, and any ranking of the potential explanations is subject to significant uncertainty. In the UK, the productivity slowdown has multiple inter-related causes, which have varied in importance before, during and after the financial crisis. These factors can be ranked under five distinct dimensions.

[3] *British relative economic decline revisited: The role of competition*. Crafts, N. Explorations in Economic History 49 (2012)

[4] *British relative economic decline revisited: The role of competition*. Crafts, N. Explorations in Economic History 49 (2012)

[5] *International Comparisons of Productivity – Final Estimates, 2013*, ONS, February 2015.

[6] Note: GDP per household is not a household income metric as GDP also includes Gross Operating Surplus of corporations and other measures of domestic income/production. HMT calculation: 2014 nominal GDP (YBHA) divided by 2014 ONS household estimates; *Quarterly National Accounts*, ONS, June 2015 and *Families and Households*, ONS, January 2015

[7] *Britain's Productivity Gap with the United States and Europe: A historical Perspective*. Broadberry, S. and O'Mahony, M. NIESR (2004)

[8] *International Comparisons of Productivity – Final Estimates, 2013,* ONS, February 2015.

A.9 The first relates to the idea that the financial crisis has resulted in impaired resource allocation across the economy, preventing capital and labour from finding their most productive uses and weighing on productivity growth.[9] A range of evidence supports this idea, including:

- the slowdown in total factor productivity (TFP) growth, which accounts for almost all the slowdown in UK productivity growth since 2008.[10] TFP can be thought of as the productivity gains from any given level of inputs (labour and capital) working better together – or in other words, better 'mixing' of the ingredients for growth
- a marked increase in the dispersion of rates of return on capital, and a break down between firms' employment growth and their relative productivity ranking.[11] This implies that resources were less efficiently allocated across firms following the crisis and that successful firms have been less able to expand
- the proportion of employees who move from one employer to another each quarter (the 'churn rate') fell substantially in the aftermath of the crisis and has subsequently remained low. Since the beginning of 2010 the churn rate has averaged around 28% less than it did in the five years to the crisis[12]

A.10 Second, it is likely that some sector-specific factors are also at play. Five sectors – financial services, ICT, professional services, wholesale & retail and transportation & storage – represent around 40% of the economy but have accounted for around 65% of the productivity shortfall.[13] In part this is driven by unsustainable pre-crisis trends, for example the financial sector grew around 8% annually between 2002 and 2007, a pace of growth which is now considered unsustainable.[14]

A.11 Third, the relatively low cost of labour since the crisis may have led firms to substitute away from investment, reducing the effective amount of capital workers can use and thus reducing productivity.[15] The Bank of England estimated that the weakness of business investment relative to its pre-crisis trend contributed around 2.5 percentage points to the puzzle by the end of 2013.[16]

A.12 Fourth, it is likely that 'labour hoarding' by firms may have reduced productivity in the initial phase following the financial crisis, as firms sought to hold on to labour despite falling demand for their output.[17] However, this cannot explain developments in more recent years, as employment and hiring have grown very strongly.

A.13 The fifth set of factors relates to measurement issues, which the Bank of England find could explain a small part of the shortfall.[18] Although there have been some recent statistical improvements,[19] the changing nature of economic activity in the modern economy poses measurement challenges: capturing fully the increasing quality of new goods and services for example, along with financial services measurement, forms a distinct part of the puzzle. To deliver the very highest standards Professor Sir Charles Bean has agreed to lead an independent

[9] *OECD Economic Surveys: United Kingdom*, OECD, February 2015.

[10] *Accounting for the UK Productivity Puzzle: A Decomposition and Predictions*, Goodridge, P., Haskel, J. and Wallis, G., March 2015.

[11] *Productivity and the allocation of resources*, speech by Ben Broadbent, September 2012; and *The UK Productivity Puzzle 2008-2013: Evidence from British Business*, National Institute of Economic and Social Research (NIESR) discussion paper, Riley et al, May 2015.

[12] *ONS Economic Review*, October 2014

[13] HMT calculations using ONS GDP low level aggregates, Quarterly National Accounts and Workforce Jobs.

[14] ONS Quarterly National Accounts, GDP low level aggregates

[15] The UK Productivity and Jobs Puzzle; Does the answer lie in Labour market flexibility? Pessoa and Van Reenen.

[16] *The UK productivity puzzle*, Bank of England Quarterly Bulletin, Q2 2014.

[17] *The productivity puzzle: a firm-level investigation into employment behaviour and resource allocation over the crisis*, Bank of England Working Paper No. 495, April 2014.

[18] *The UK productivity puzzle,* Bank of England Quarterly Bulletin, Q2 2014.

[19] Such as the UK implementation of the ESA10- the European System of National and Regional Accounts

review of the quality, delivery and governance of UK economic statistics. The review will build on the established principle of independently produced statistics and make interim recommendations in the autumn with a final report to be published by Budget 2016.

Raising productivity

A.14 Productivity is a measure of how well resources are converted into goods and services. Raising productivity can be achieved by improving the quality of the resources, and the way that we combine them. There is an analogy to cooking: we can raise living standards by improving the ingredients we have, and by using better recipes.

A.15 The government's framework for raising productivity is built around two pillars:

- encouraging long-term investment in economic capital, including infrastructure, skills and knowledge
- promoting a dynamic economy that encourages innovation and helps resources flow to their most productive use

Encouraging long-term investment

A.16 Nearly every theory of productivity growth retains a central role for investment and the accumulation of capital. Investment raises the long run productivity of nations by increasing the level of capital that each worker has at their disposal.

A.17 In today's economy, investment is about much more than machines, equipment and physical infrastructure. It also encompasses the development of human capital from education and training, and intellectual capital stemming from research, as well as the development of software and improved business processes. These are all interlinked and thrive in an economy that has well developed institutions and high levels of social capital.[20]

A.18 There is evidence of insufficient or ineffective investment in the UK, notably in developing economic infrastructure and improving the basic and intermediate skills of the workforce, particularly technical and vocational skills.[21] Firms have held back on capital investment since the crisis, and this exacerbated a persistent UK weakness.

A.19 There is clearly scope to do better, but these simple comparisons of spending do not tell the whole story. After all, the UK experienced faster productivity growth than most other advanced economies during a period where this investment 'gap' was large.

A.20 The effect of investment depends not just on its volume, but on how it is spent and how effectively it is allocated across the economy. As an example, the UK's expenditure on science is below the OECD average, but it achieves much better outcomes in terms of research quality. [22]

A.21 Many of the UK's comparative strengths are in sectors that tend to have less need to invest in machines and equipment. Knowledge assets ('intangibles'), many of which are not captured in national accounts, are critical for these firms. Research shows that these investments make an important contribution to productivity growth for the UK economy as a whole. The UK now invests 44% more in intangibles than in traditional assets, and more than many other advanced countries as a share of GDP. [23] When all forms of investment are considered together, the investment gap with other countries narrows significantly – over the period 1995-2007, total

[20] *Growing – fast and slow*, Haldane, A. Speech at the University of East Anglia (2015); 'Institutions as the fundamental cause of long-run growth' Acemoglu, D., Johnson, S. and Robinson, J. NBER Working Paper 10481 (2004)

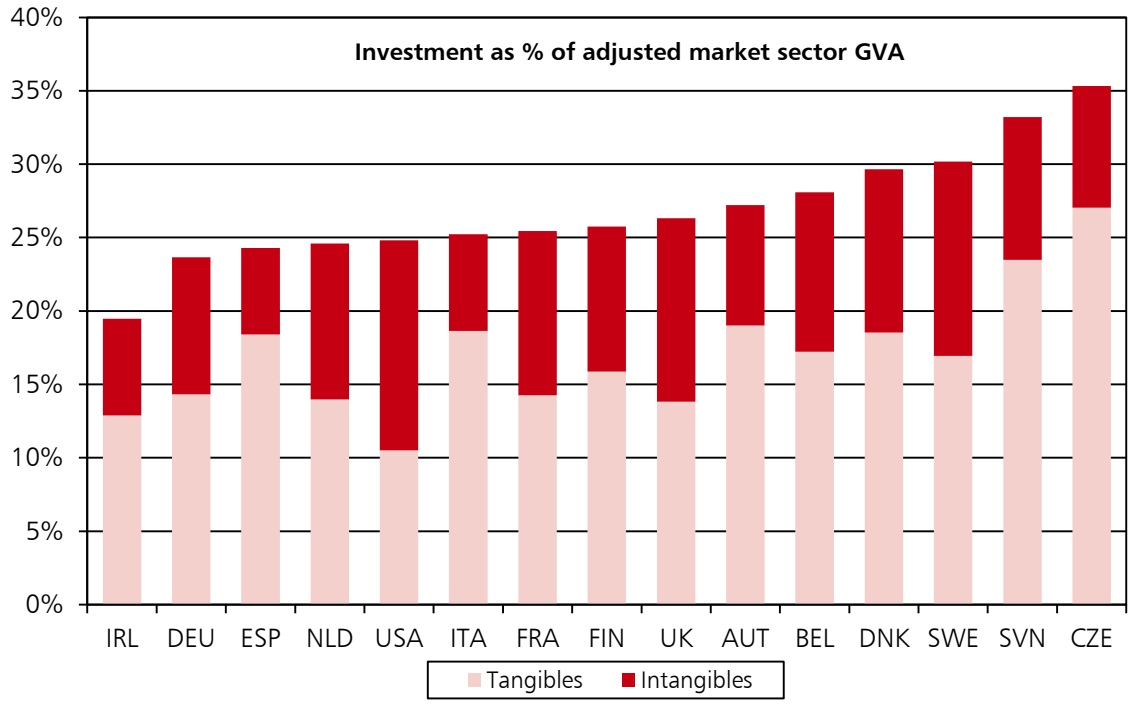
[21] *Investing for prosperity: skills, infrastructure and innovation*. LSE Growth Commission (2012)

[22] See Chapter 8.

[23] *Estimating UK investment in intangible assets and IP rights*. Goodridge, P., Haskel, J. and Wallis, G. Intellectual Property Office (2014)

investment as a share of GDP was higher in the UK than in France, Germany and the US (Chart A.2).

Chart A.2: Investment in tangible and intangible assets, 1995-2007



Source: HM Treasury calculations, Corrado, Carol; Jonathan Haskel, Cecilia Jona-Lasinio and Massimiliano Iommi, (2012), Intangible Capital and Growth in Advanced Economies: Measurement Methods and Comparative Results Working Paper, June, available at http://www.intan-invest.net.

A dynamic economy

A.22 A dynamic and productive economy is one that deploys its resources to greatest effect, enabling them to flow where they create most value. Recent OECD research shows that poorly allocating resources within the economy can have significant negative effects on aggregate productivity.[24] The evidence of impaired resource allocation since the crisis suggests a lack of dynamism may also have contributed to the puzzle.

A.23 Aggregate productivity improves in two ways: when individual firms become more efficient and when capital and labour move to firms or sectors that are relatively more productive. The importance of each of these mechanisms varies by sector, and over time. A recent study estimated that approximately one half of productivity growth in the pre-crisis period was the result of re-allocation across firms.[25]

A.24 There is considerable variation in firm productivity levels across the economy. On average, some sectors are more productive than others, but the variation within sectors is much greater, as demonstrated by recent ONS research on productivity dispersion in three broad sectors.[26]

[24] *The Future of Productivity*. Adalet McGowan, M., Andrews, D., Criscuolo, C. and C Nicoletti, G. OECD. (2015)

[25] *The productivity puzzle: a firm-level investigation into employment behaviour and resource allocation over the crisis*. Barnett, A., Chiu, A., Franklin, J. and Sebastia-Barriel, M. Bank of England Working Paper 495 (2014)

[26] *Microdata perspectives on the UK productivity conundrum – an update*. ONS. Values are at 2005 prices.

Large variation persists even when sectors are narrowly defined: the top 10% of firms in each industry can be as much as five times as productive as the bottom 10%.[27]

A.25 Economies suffer if too many resources get tied up in unproductive firms. Likewise, there are potentially significant gains for an economy that enables the most productive firms to expand, facilitates market entry by disruptive innovators and ensures competitive pressure on the tail of low productivity firms. This requires an open economy with flexible and competitive markets, where expanding firms can access the labour, land and finance they need.

A.26 Dynamism is also important for new ideas – new technology and processes do not have a transformative effect on productivity until they spread throughout the economy. One study estimated that just 13% of UK growth in recent decades came from knowledge created in the UK.[28] The challenge is to make the most of ideas from wherever they come, and to help best practice to spread.

A.27 Although the labour market is a great strength of the UK's, still more can be done to help move skilled workers to the right jobs. Reducing skills mismatch to the level of the best in the OECD could raise productivity by approximately 5%.[29] In particular, the UK economy under-utilises the talent of women: girls outperform boys at school and women have the same relevant skills as men, yet 57% of women are in low or lower middle skill jobs, compared to 36% of men.

A.28 Cities are the foundation of a dynamic economy, providing deep markets for labour and enabling rapid diffusion of ideas and vibrant competition between firms. The concentration of activity within cities itself contributes to productivity through the sharing of knowledge and ideas; the pooling of labour, through specialisation and the matching of supply and demand.

The sectoral dimension

A.29 Aggregate productivity masks significant variation across the economy and three groups of sectors can be identified in terms of their pre- and post-crisis performance:

- sectors such as oil and gas where productivity growth was weak both before and after the crisis. These are likely to have contributed to both the long term productivity gap and the more recent productivity puzzle
- sectors such as financial services, which performed well pre-crisis but have fared badly since. These are likely to be contributing to the more recent productivity puzzle, but less so to the long run productivity gap
- sectors such as automotive where productivity growth was strong in both the pre-crisis and post-crisis periods. These are unlikely to be contributing to the productivity puzzle but may still have a role to play in helping to tackle the UK's productivity gap.[30]

A.30 While the sources of productivity growth are similar across the whole economy, they vary in importance for different sectors. A sector level approach can be appropriate, for example targeting competition and deregulation measures where they can have the greatest productivity benefit.

A.31 This plan responds to the recent slowdown of productivity across the UK and, perhaps more importantly, to the long-standing gap compared to other countries.

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[27] *Building the evidence base for productivity policy using business data linking* Criscuolo, C, Haskel, J and Martin, R (2003), Economic Trends 600

[28] *International Technology Diffusion: Theory and Measurement*, Eaton, J. and Kortum, S. (1999)

[29] *Labour Market Mismatch and Labour Productivity: Evidence from PIAAC Data*, OECD Economics Department Working Papers 1209 (2015)

[30] BIS calculation: *Quarterly National Accounts*, ONS, June 2015; *Labour Market Statistics,* ONS, June 2015

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CONNECTED FUTURE

NATIONAL
INFRASTRUCTURE
COMMISSION

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CONNECTED FUTURE: IN BRIEF

5G means seamless connectivity. Ultra-fast and ultra-reliable, transmitting massive amounts of data at super low latency. It will support the ever increasing requirements of the existing network and new applications as unknowable today as the 4G services we take for granted would have been a decade ago.

Securing the mobile networks necessary to put the UK at the forefront of this emerging technology will be critical to the growth of our economy. This report makes recommendations to make that happen.

The Commission's central finding is that mobile connectivity has become a necessity. The market has driven great advances since the advent of the mobile phone but government must now play an active role to ensure that basic services are available wherever we live, work and travel, and our roads, railways and city centres must be made 5G ready as quickly as possible.

PART 1: THE MOBILE REVOLUTION

The UK mobile market has transformed from a luxury in the 1980s to an essential today. 93% of adults in the UK own a mobile phone, smartphones have overtaken laptops as internet users' device of choice, and there are more mobile devices than people.

Yet the UK's networks are not complete. There are too many digital deserts across the country and the availability of our 4G network is worse than many countries including Albania, Panama and Peru.

PART 2: GOVERNMENT AS A DIGITAL CHAMPION

The market has driven enormous change – but now government must take responsibility to secure our digital future, starting with the creation of a strong digital champion backed by a dedicated cabinet committee.

Government must ensure we have the infrastructure in place to deliver 5G across our major centres and transport networks.

Major roads: Our motorways must have roadside networks fit for the future. The infrastructure should be in place by 2025.

Key rail routes: The railway network must rapidly improve connectivity. This will be best delivered in future by a trackside network. Government should provide a plan by 2017, and the infrastructure should be in place on main rail routes by 2025.

Towns and cities: Local Authorities and LEPs should work with network providers to develop approaches that enable the deployment of the tens of thousands of small wireless cells we expect to need in our urban centres.

PART 3: ENABLING THE MARKET TO DELIVER WHAT WE NEED

Government and Ofcom must ensure basic outdoor mobile services are available wherever we live, work and travel.

Regulation must keep pace with the rapid evolution of the mobile communications markets, allowing innovative new firms to provide services that the existing market has not delivered.

Greater connectivity is inevitable and essential. The UK cannot be left behind.

CONNECTED FUTURE AT A GLANCE

1G Analogue voice transmission

2G Digital talk and text

3G Data services become a core part of mobile phones

4G High speed internet access

5G Ultra-fast, ultra-reliable, mobile connectivity able to support ever larger data requirements

The market has driven great advances since the advent of mobile technology, but now Government must play a role in securing the more comprehensive coverage required for 5G.

5G City Centres

Local Authorities and LEPs should work with network providers to enable the deployment of the tens of thousands of small cells we will need in our urban centres.

Motorways

It is vital that our motorways have mobile networks fit for the future. Infrastructure should be in place by 2025.

Rail

The railway network must rapidly improve connectivity. Government should provide a plan by 2017, and the infrastructure should be in place on key routes by 2025

A universal service obligation for mobile

Mobile connectivity has become a necessity, consumers should enjoy essential services wherever they live, work and travel.

The UK is currently 54th in the world for 4G availability. Even our city centres are still plagued by 'not spots' - areas without any coverage at all.

EXECUTIVE SUMMARY – 5G AND THE FUTURE OF MOBILE NETWORKS

BACKGROUND

The National Infrastructure Commission (NIC) was asked to advise government on the steps the UK should take in order to become a world leader in the deployment of 5G mobile telecommunications networks, and ensure that the UK can take early advantage of the applications those networks may enable.

Since the spring, the NIC has engaged extensively with a wide range of stakeholders across industry, government and civil society in order to inform an analysis of future mobile telecommunications in the UK.

5G is expected to deliver a step change of ultrafast, low latency, reliable, mobile connectivity, able to support society's ever larger data requirements as well as wide ranging new applications. From connected and autonomous vehicles to an Internet of Things, 5G has the potential to be transformative across a number of sectors including health, transport and education, and will bring new innovations as unknowable today as the mobile apps and services we now take for granted were a decade ago. Securing the mobile networks necessary to put the UK at the forefront of this emerging technology will be critical to the UK's growth and to drive our industrial base into the internet applications and services economy.

The Commission's central finding is that mobile connectivity has become a necessity. The market has driven great advances since the advent of the mobile phone. But Government must now play an active role to ensure that basic services are available wherever we live, work and travel, whilst our roads, railways and city centres must be made 5G ready as quickly as possible.

PART 1: THE MOBILE REVOLUTION IN CONTEXT

In the thirty years since the first mobile cellular network was deployed in the UK, mobile communication has transformed how we live and work. This mobile revolution is widely expected to accelerate over the coming decades, resulting in a step change whereby the primary way we will access our digital lives, control our devices and absorb information will be mobile, wireless, rapid and reliable.

The UK mobile market has grown enormously since the 1980s, and mobile connectivity has been transformed from a luxury to an essential part of peoples lives. Today, 93% of adults in the UK own and use a mobile phone, smartphones have

overtaken laptops as internet users' device of choice, and there are more mobile devices than people. The mobile sector contributes an estimated £4.5 billion per annum to national economic output and is a major British industry in its own right, with the four largest mobile operators providing over 35,000 full-time equivalent jobs, and supporting some 140,000 UK jobs overall.[1]

The development of mobile communications, whilst rapid, has been an evolutionary process, with each mobile generation introducing improvements in quality and functionality. In the early 1980s, the first generation of mobile (1G) allowed for analogue transmission using the electromagnetic spectrum to send 'voice' in essentially the same way as any two-way radio. In the early 1990s, 2G was characterised by the adoption of digital transmission and switching technology, which increased the capacity and efficiency of networks and allowed for text messaging and some early data-based services. Whilst 2G networks resulted in significant growth in subscriber numbers, however, it was only with the advent of 3G in 2003 that data services became a core part of mobile phone use. The smart phone drove the adoption of the mobile internet, with speeds steadily improving, and audio and video streaming becoming feasible over mobile networks, as new technologies have been developed and introduced.

The introduction of 4G services, since 2012, has provided access to considerably faster data speeds and lower latency, and given rise to the various new services and applications we are now accustomed to in the smart phone age. This has resulted in an enormous increase in data rate usage per user, as streaming of services, such as video becomes commonplace. 2014 saw total data demand increased by 53 per cent in the UK (per active mobile SIM), similar to the increase seen in 2013.

As a result of these advances and the ability for increasingly sophisticated mobile devices to reach a mass market, mobile telecommunications and mobile services more broadly, are now established at the heart of our society and economy. They have fundamentally changed how we stay in touch, make purchases, view entertainment and participate in wider networks, and are increasingly important to business, where a digital transformation is underway. Indeed, a basic level of mobile service provision is increasingly regarded as a utility.

However, the UK lacks the level of coverage necessary to offer these basic mobile services ubiquitously. In rural areas 3% of the population do not have any coverage outside their homes (complete not-spots) and 25% do not have coverage offered by all the main mobile networks (partial not-spots). Coverage on our road networks is poor even for voice coverage (2G), 17% of A and B roads are in complete not-spots and an additional 42% have only partial coverage.

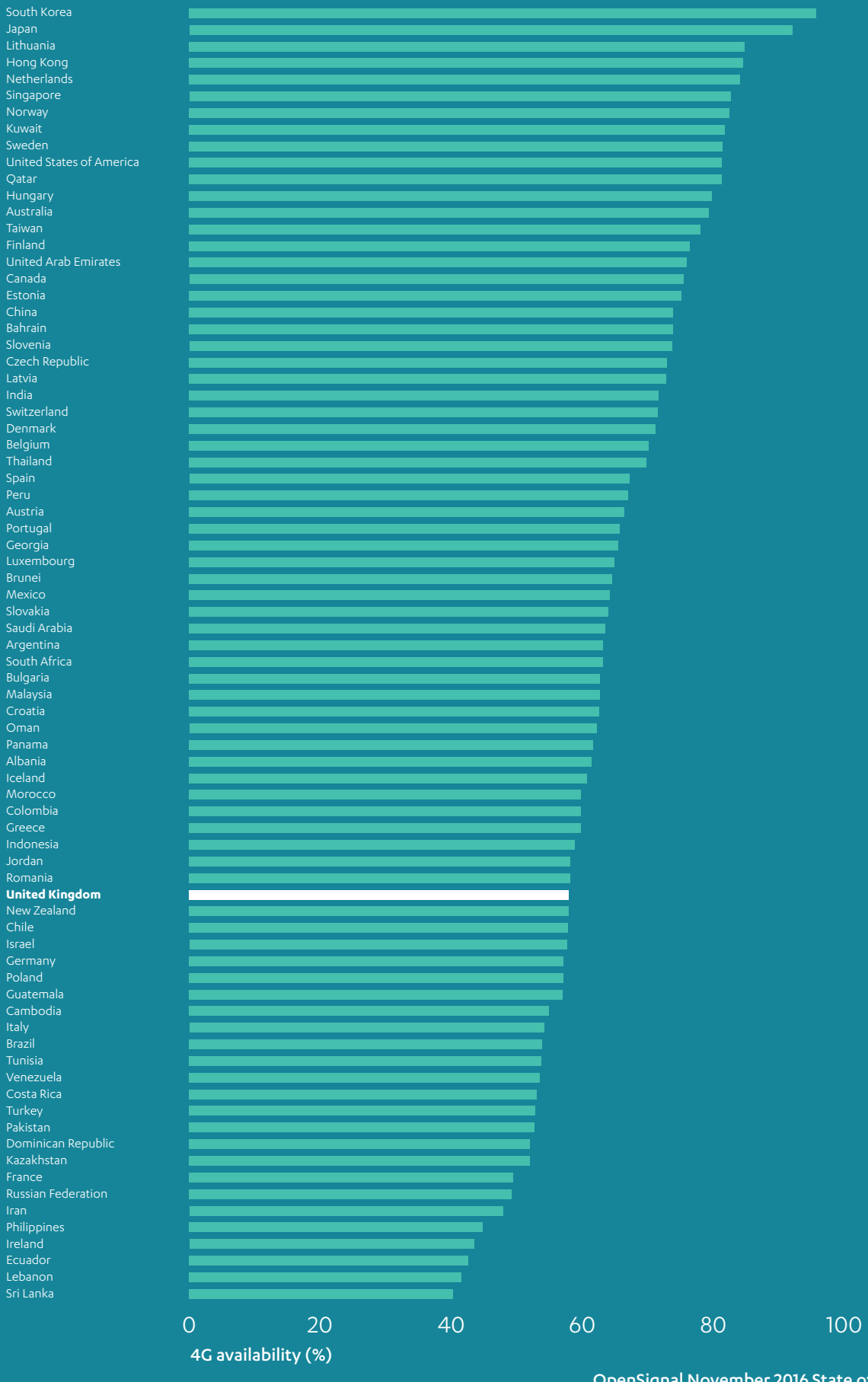
The UK performs poorly in comparison to other countries when looking at the availability of 4G – a metric that captures how much of the time a phone is able to connect to the 4G network (see chart below). This is driven to some extent by the fact the UK was significantly later than other countries in making 4G spectrum available, in part due to delays in the 4G spectrum auction stemming from operators threatening litigation around auction conditions. The first 4G auction in the US took place in 2008, compared with the 4G auction in the UK enabling all operators to deploy being held in 2013, with EE having begun deployment using its existing spectrum in 2012.

This delay means that operators in the UK are still in the process of deploying 4G networks. Although government has agreed with operators that they should deliver 90% geographic coverage for voice and text by 2017, it is not clear that this will meet consumer service expectations. As it stands, gaps in current 4G networks mean that around 20% of urban premises and almost 80% of rural premises are in a not-spot for 4G coverage.

The next generation of mobile connectivity will need to deliver the right type of networks, in the right places, for the services that people and business need. This means that 5G networks cannot be thought of in isolation but must be considered as part of a wider ecosystem of mobile connectivity. Delivering the connectivity we require for the future must start by ensuring that we have the networks we need for today – this will not only provide a basic level of service to consumers now but also the backbone of the network infrastructure we need for the new services of the future.

Only 8% of A and B roads have complete **4G coverage** with 47% having no 4G coverage at all

4G AVAILABILITY



OpenSignal November 2016 State of LTE Report

What is 5G?

5G is the next generation of mobile. Standards are due to be agreed in 2019 followed by gradual introduction from the early 2020s, but with full deployment unlikely until the 2030s. As well as existing spectrum bands, 5G technologies will use very high frequency spectrum, enabling rapid data transfer speeds and making it easier to download/upload on mobile devices. Where 5G networks are deployed, they will build on and add to the foundation created by previous mobile generations. This will be critical as the high frequency 5G technologies will only be able to transmit data across short distances; high quality wide area coverage will therefore continue to be essential.

The emergence of 5G will result in more complex and interconnected networks. Over time, the boundaries between, for example, fixed connectivity such as Wi-Fi and mobile, will become blurred giving users the sense of always on, high quality and rapid connectivity.

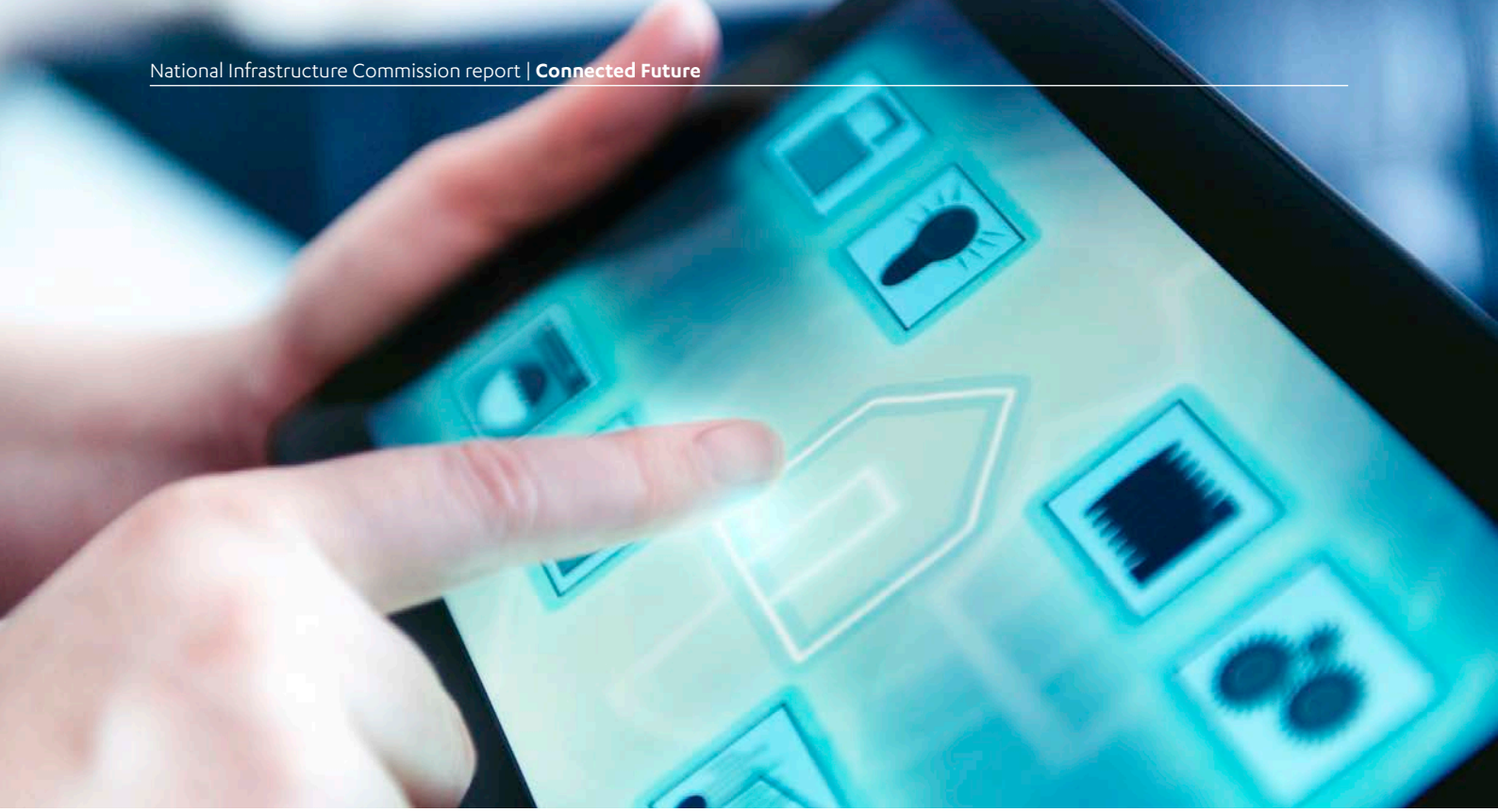
5G will also provide capacity for the many thousands of internet-connected devices, such as wearable health sensors, that are predicted to proliferate and enter our everyday world (known as the Internet of Things) and will underpin a number of new anticipated applications across a variety of sectors.

In the automotive industry, the low latency and high capacity capabilities of 5G will help facilitate the evolution of highly connected and, ultimately, fully autonomous vehicles. And, in sectors as varied as healthcare and gaming, the potential for new services – like real time health monitoring and augmented reality to improve lives and generate growth is enormous.

Realising these benefits will require the deployment of tens of thousands of new small cell mobile base stations connected to fibre optic cables, which will necessitate investment, coordination and removal of a number of regulatory barriers. In order to pave the way towards the vision of an always on, reliable and high speed network, it will be vital to address existing issues, such as areas of poor coverage.

Although all of the services that future mobile networks will enable cannot be known in advance, certain characteristics of future network requirements – such as the need for ever more data, reliability and connectivity across a range of sectors – are clear. Indeed, countries such as the United States and Japan already have data volumes four to five times higher than the UK, and are predicted to carry on growing exponentially.

The potential for mobile networks to enable innovative new services opens up manifold opportunities for the UK to exploit in fields such as connected and autonomous vehicles and the Internet of Things (IoT). Improved connectivity can help the UK get the most from its existing infrastructure, for example through



remote sensors enabling more efficient maintenance and the smart management of energy and water demand. The development of new services to make use of this level of connectivity will also bring UK plc a range of benefits, although as the fabric of our daily lives and our infrastructure becomes increasingly underpinned and reliant on advanced connectivity ensuring robust cybersecurity will also be critical.

Countries such as the United States and Japan already have data volumes four to five times higher than the UK

Other countries already have the advantage in terms of manufacturing the hardware needed for 5G, and the UK will not make up that ground. But the development of new services to make use of the improved connectivity offered by 5G is an area which will build on many of the existing strengths of the UK economy and provide opportunities for British firms both at home and abroad. The UK has the potential to be amongst the leaders in growth industries developing around internet and cloud-based applications and services, and around the Internet of Things, that depend on the widespread deployment of advanced mobile connectivity like 5G. But this potential will only be fully realised if the relatively slow roll-out and availability of 4G networks is not repeated.

The NIC's analysis suggests, however, that Mobile Network Operators (MNOs) will struggle to deliver these networks in the locations and at the speed needed without government assistance, supporting and coordinating the investments made by the private sector. A lack of government action risks the UK finding itself once again near the bottom of the league tables for connectivity as 5G is rolled out.

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Getting 5G deployment right will be critical in a future where connectivity is becoming integral to almost all parts of the economy, and the UK will put its future growth and competitiveness at risk if it falls behind.

PART 2: DIGITAL INFRASTRUCTURE AT THE HEART OF GOVERNMENT

Government as a digital champion

Given the importance of the UK's digital infrastructure – a key component of which is mobile telecommunications – it is notable that there is no single government department with responsibility for it. Instead, the government's interests in digital infrastructure are fragmented and entwined with the wider policy interests of numerous departments and agencies. For example, the Home Office's procurement and delivery of the Emergency Services Network is a major telecoms project and many of the projects for which the Department for Transport has responsibility, such as roads and railways investment and upgrades have a significant digital component. These activities do not have national mobile connectivity as a core objective. This risks the deprioritisation of telecommunications within them, resulting in a patchy, uncoordinated approach and missing the huge opportunity that digital infrastructure offers at a relatively small cost for the country's other infrastructure networks and wider economy.

Given the increasing importance of connectivity across all parts of the economy, digital infrastructure should sit at the core of the government's industrial strategy, ensuring that the UK can take full advantage of technologies such as artificial intelligence and augmented reality, and the needs of new industries, to improve productivity and develop the businesses of the future.

To grasp the inherent opportunities that digital infrastructure offers, there must be a single part of government, with senior ministerial and official leadership and supported by a well-equipped and powerful unit, that is responsible for setting the UK's overarching plan for digital infrastructure and ensuring that it is delivered in a coordinated way. The creation of a Director General lead in the Department for Culture, Media and Sport (DCMS) is a good first step.

Recommendation 1: Digital infrastructure lies at the heart of the UK's industrial strategy and affects every sector of the economy. To reflect its importance, ultimate government responsibility for digital infrastructure should reside in one place under a single cabinet minister with the authority to shape policy and delivery across government, ensuring that it delivers the government's overarching digital strategy. This work should report to the Economy and Industrial Strategy Cabinet Committee. It should:

- Identify the public projects that contain a significant element of digital infrastructure and establish and maintain a plan which sets out how they can help deliver the government's overarching digital strategy and maximise the benefit of better mobile telecommunications for UK citizens and businesses.
- Hold the various parts of government that are delivering digital infrastructure to account, in order to ensure adequate telecoms network provision in the delivery of its infrastructure programmes.
- Ensure that when upgrading existing or delivering new infrastructure, such as that alongside our roads and railways, the long term capacity needs of telecoms networks are considered and met. This could include installing more fibre and additional infrastructure to make sure that networks are future-proof. It will also mean ensuring that the networks are readily accessible to communications providers.
- Be a centre of telecoms expertise within government that supports departments in determining their needs and procuring telecoms infrastructure, and support departments in demonstrating and testing of new, digitally-enabled ways of delivering public services such as education and healthcare.
- Support and challenge local government in their plans to enable the delivery of digital infrastructure; both in terms of ensuring that these plans help the UK to meet its national objectives, and that local authorities develop consistent approaches to support the deployment of mobile infrastructure across the country.



Connectivity on our major roads

4,400 miles of Strategic Road Network (SRN), which are managed by Highways England, form a critical spine for enormous volumes of traffic.[2] Some 1,865 miles of the SRN in England are motorways, which comprise just over 1% of the total length of the entire road network, but carry 21% of all vehicle traffic (miles). Motorways are therefore crucial in linking communities and allowing us to commute to work, transport goods and visit friends and family.[3]

Given the importance of road transport, the impact that technology can have on the sector in the future has the potential to be transformative. A great deal of investment has driven progress in the development of connected and autonomous vehicles, including government support for research and development, but ensuring the necessary digital infrastructure is in place will be critical if the UK is to take advantage of this technology.

Predictions about the pace of mass deployment of fully autonomous vehicles vary, but most in the industry consider it to be inevitable in the longer term. Before that end point is reached, increasingly connected vehicles will be capable of delivering near term capacity, safety, environmental and information/entertainment benefits, as well as helping to pave the way towards full autonomy. In the UK, world leading automotive companies – such as Jaguar Land Rover – are delivering the innovation that will allow for increasingly sophisticated, connected vehicles.

However, without the appropriate underpinning mobile network infrastructure, the development and mass deployment of connected vehicles in the UK will be hindered.

Work commissioned by the NIC has estimated costs for a telecoms network that makes best use of existing roadside infrastructure alongside England's motorways to be in the order of £380 million. This network could be a commercial asset selling connectivity services to drivers, MNOs and the public sector, and the strategy for its deployment should aim to maximise private sector funding.

Recommendation 2: Our motorways must have mobile telecommunication networks fit for the future. It is vital that our motorways are able to meet both the long term operational needs of connected vehicles and the connectivity needs of the passengers. This will necessitate the timely installation of an open and accessible mobile telecommunication and backhaul network that is fit for the future.

The government should set out its plans for how to deliver this by the end of 2017. As part of this work consideration should be given to who is best placed to install, manage, fund and own the network, noting the potential for private sector funding.

Ensuring that best use is made of the existing infrastructure, such as masts, poles, ducts power supplies and the fibre network alongside our motorways, so that it can be used to support the backhaul of mobile data will be essential.

Ultimately, the government should ensure that the necessary infrastructure is in place on motorways by 2025 at the latest if it wants to offer a reasonable level of connectivity on a timescale consistent with the deployment of 5G networks.

Ofcom should set out how a regulatory regime would support these different operating models.

The provision of a robust and forward looking communications network infrastructure on our motorways should inform the process for ensuring that there is adequate coverage and capacity on the rest of the road network to meet future needs, including the partnerships needed between road stakeholders and mobile communications providers.



Connectivity on our main rail routes

There is huge demand for rail travel in the UK and it has seen strong growth with passenger numbers more than doubling since 1996/97 and some 1.7 billion passenger journeys made last year.[4, 5] However, mobile coverage on our rail routes is notoriously poor; making it difficult to carry out tasks taken for granted in many other contexts, such as making a phone call or checking emails. Although unreliable and patchy coverage on the railways is in part a consequence of difficult geographies, such as tunnels and cuttings, these issues are not insuperable.

The current model of delivery through existing mobile networks of towers set some distance from railway lines is enabling some of the most immediate challenges to be addressed but it is unlikely to be a cost effective means for achieving high capacity continuous connectivity to trains in the long term, and will become increasingly substandard as passenger data requirements increase. A different model will be necessary, one which relies on trackside infrastructure to support the deployment of high capacity wireless connectivity.

This will require the upgrade of our existing key mainline and metro rail routes, including the London Underground, and should be built in from the start for any new lines.

Improved trackside communications can also support a resilient and high performance operational network for our railways. Indeed, investment in the operational side of railway telecommunications must in future take full consideration of passenger needs, and vice versa.

Work commissioned by the NIC has estimated costs for such an approach to be in the order of £500-£600 million for the UK's main rail routes. In a similar model to a roadside telecoms network, this network could ultimately be a commercial asset selling connectivity services to train operators, MNOs, and the public sector, and the strategy for its deployment should aim to maximise private sector funding.

Recommendation 3: Rail passengers should have high capacity wireless connectivity. This should be achieved through a delivery model that utilises trackside infrastructure to provide an open and accessible mobile telecommunication and backhaul network that is fit for the future.

The government should set out its plans for how to deliver this by the end of 2017. As part of this work consideration should be given to who is best placed to install, manage, fund and own the network, noting the potential for private sector funding.

Ensuring that best use is made of the existing infrastructure, such as masts, poles, ducts power supplies and the fibre network alongside our railways so that it can be used to support the backhaul of mobile data will be essential.

Ultimately, the government should ensure that the necessary infrastructure is in place on the main rail and key commuter routes by 2025 at the latest if it wants to offer a reasonable level of connectivity on a timescale consistent with the deployment of 5G networks.

Ofcom should set out how a regulatory regime would support these different operating models.

Engaging local government as a partner

Delivering the mobile services envisaged for the future will require dense networks of potentially tens of thousands of new 'small cell' radio antennae in our towns and cities. This will allow for increased capacity requirements resulting from the predicted growth in data use from both people and machines to be met. It will also help to provide the underpinning infrastructure that will be necessary for a number of smart city tools and technologies to be introduced, such as the use of sensors and real time data feeds to tackle traffic congestion. However, there will be a significant challenge both in finding suitable sites and infrastructure to support these cells, and ensuring that telecoms networks meet local needs.

Recent planning changes and an amendment of the Electronic Communications Code have gone a long way to removing existing planning barriers. But Mobile Network Operators (MNOs) will need to bring together their network expertise with that of local authorities, who best understand their area and can provide an accurate picture of local area requirements.

Recommendation 4: Local government should actively facilitate the deployment of mobile telecoms infrastructure:

a) Local authorities should work together and with Local Enterprise Partnerships (LEPs) to develop coordinated local mobile connectivity delivery plans. These plans should:

- set out how local authorities and LEPs will enable the deployment of mobile networks and maximise the opportunities and benefits to residents and businesses;
- be developed in discussion with mobile network operators and infrastructure owners;
- identify a designated individual with lead responsibility for engaging with mobile telecoms infrastructure providers;
- consider the role of local government assets and infrastructure, (e.g. land, buildings, roads, street furniture) and help coordinate the role that other public buildings in an area (e.g. hospitals and universities) can play to facilitate the deployment of mobile telecoms infrastructure; and
- consider how the deployment of digital infrastructure can be established as a priority in local planning policy.

Local authorities and LEPs should report annually to the government department with responsibility for digital infrastructure on their progress delivering against these plans.

b) Local models for facilitating the deployment of these networks should be piloted and evaluated to inform national roll-out. Any pilot programme should allow for the evaluation of deployment models in different types of area (e.g. urban, rural, coastal) and in both single-tier and two-tier local government areas. It should also seek to establish how high quality design can minimise the impact of hosted infrastructure on the built environment. Such pilots would be a good use of a proportion of the funding recently announced in the Autumn Statement to support mobile telecoms infrastructure.

PART 3 – ENABLING THE MARKET TO DELIVER WHAT WE NEED

Meaningful coverage

In February 2015, Ofcom varied the licences of the UK's four MNOs to commit the operators to providing 90% geographic coverage for voice calls by the end of 2017.[6] Additional sites are being deployed in order to meet this commitment and to achieve an improvement in indoor data coverage to 98% of premises. And, as part of the UK government's new Emergency Services Mobile Communications Programme, EE will be building more than 500 additional 4G sites which will have the added benefit of providing increased coverage for their mobile customers.[7]

However, although geographic coverage data offers a good indication of the reach of mobile voice and data services, the picture is incomplete in terms of mobile user experience. For example, a recent study (April 2016) by Which? and independent mobile coverage experts OpenSignal found in their November 2016 'State of LTE' report that mobile customers across the UK's four networks were on average able to access 4G just 53% of the time. This indicates that network availability from a user perspective is lower than that suggested by overall coverage statistics.

Combined with poor coverage on large parts of our transport network, this suggests that improvements are necessary. The urgency of this is highlighted by the CBI's recent finding that 81% of firms see more reliable mobile connectivity as essential. As a minimal level of mobile service becomes more and more important – and increasingly similar to a utility – this patchy network picture will become untenable.

Provision of outdoor mobile services remains a challenge. Government and Ofcom should act to address this now, particularly as the emergence of 5G technology is unlikely to provide a solution but instead will itself require the right basic infrastructure to be in place.

Independent mobile coverage experts OpenSignal found in their 'State of LTE' report that mobile customers across the UK's four networks were on average able to access 4G just ***53%*** *of the time*

Recommendation 5: Government and Ofcom should develop a meaningful set of metrics that represent the coverage people actually receive and use these to determine a mobile universal service obligation setting out the minimum service level people should expect to receive.

a) Ofcom, government and mobile operators should report their coverage so that they are genuine and meaningful reflections of the services enjoyed by customers. Metrics should be measurable and based on the reality of service and coverage provided to customers, not based on simulated or predicted performance. Ofcom should set out how this is best achieved by the end of 2017.

Ofcom and government should use these metrics as the basis of future interventions such as spectrum licence obligations or voluntary agreements with operators.

Government, Ofcom or the Advertising Standards Authority should take action if operators advertise or report coverage in a way that does not reflect services being delivered to consumers on an everyday basis.

b) Mobile services are increasingly viewed as essential, underpinning our daily lives and the digital economy. Government must deliver a view by the end of 2017 on what aspects of mobile services are considered "essential". It should then establish how this "essential" level of service provision can be made available through a mobile universal service obligation regardless of the network to which a customer is subscribed. Government should engage with Ofcom and industry to establish the best delivery mechanism, whether through spectrum licence obligations, enabling roaming, enabling cross operator Mobile Virtual Network Operators (MVNOs), through government procurement or a mix thereof.

Government with the assistance of Ofcom should deliver this as soon as is practical but no later than 2025.

Regulation that is fit for the connected future

The future of mobile looks different to the past and enabling that future will necessitate regulatory change. Delivering extensive coverage at high data speeds and with robust reliability, with each operator running a separate network, would require vast levels of investment. There must be an increased role for infrastructure sharing, not only to reduce the costs of network deployment where possible but to make best use of the limited supporting infrastructure such as street furniture in our towns and cities. Any regulation of network infrastructure should seek to be supportive of this sharing, whilst ensuring competition and fair access are maintained.

In addition, the paradigm of competition in all areas of the mobile market may break down in coming years, particularly where the business case for the private sector to deploy mobile telecoms infrastructure is weak, such as rural areas. It may be necessary to allow a single set of infrastructure that supplies services to all.

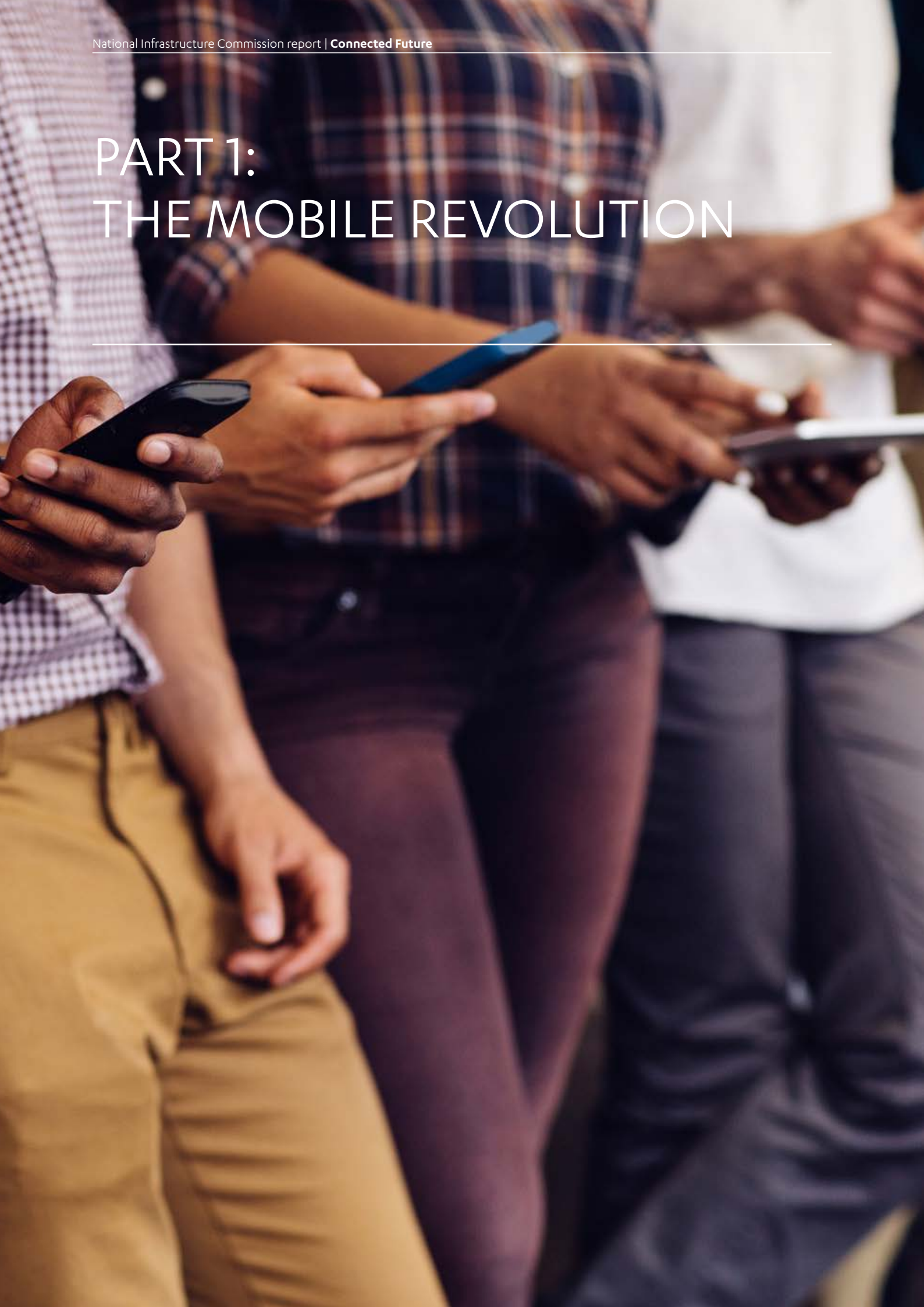
Recommendation 6: By the end of 2017 Ofcom and government must review the existing regulatory regime to ensure that it supports the sharing of telecoms infrastructure. This will be particularly important for areas of the country where competition driven markets have struggled to provide the necessary mobile infrastructure.

As well as lower frequency radio spectrum, 5G expects to make use of very high frequency millimetre wave radio spectrum, provided by dense networks of very small mobile cells. These are not anticipated to be deployed outside of urban centres and other 'hot-spots' by mobile operators. Auctioning spectrum licences in large, national scale blocks, at these very high frequencies, risks a significant share of the radio spectrum lying fallow in large parts of the country, because deploying the dense networks described above may not be profitable for the major operators in these areas, yet the spectrum will still be inaccessible to other users. This could act as a barrier to entry for new firms to compete in the provision in mobile services and may impede the most widespread deployment of 5G high frequency small cells.

Recommendation 7: Ofcom and government must ensure they keep pace with the rapid evolution of the mobile communications market, and that the regulatory regime is fit for purpose. By the end of 2017 Ofcom and government must review the regulatory regime to ensure that spectrum allocation and regulatory decisions support a growth model in a world where technology developments enable greater shared access and interoperability. Government and Ofcom should review how unlicensed, lightly licensed spectrum, spectrum sharing and similar approaches can be utilised for higher frequencies to maximise access to the radio spectrum. Spectrum decisions should where possible enable:

- Community or small provider solutions to meet the needs of local areas if they remain unserved or poorly served.
- Niche entrants or sub-national players to access the higher frequency spectrum anticipated for 5G. Allocation of nationwide spectrum licenses to a small number of operators could leave large areas of the UK fallow.
- Businesses, universities and others to access spectrum where they need to within their factories or buildings, including already licensed spectrum if there are no interference risks. This will unlock multiple wireless service provider options, including self-provision, spurring the innovation in industrial internet of things, wireless automation and robotics.

PART 1: THE MOBILE REVOLUTION



The significance of mobile communications

1.1 In the thirty years since the first mobile network was deployed in the UK, mobile communications have transformed how we live, work and play. Wireless is the principal means of accessing the internet and the services it offers. Today, 93 per cent of adults in the UK own and use a mobile phone, and smartphones have overtaken laptops as internet users' device of choice.[8] The services accessed via mobile devices have fundamentally changed how we stay in touch, make purchases and participate in wider networks, and are increasingly critical to business, creating an ever more connected society. A digital transformation has been described as taking place across various industries, with digital technology acting as an enabler of "fundamental innovation and disruption".[9]

1.2 Mobile communication is a central part of this story, helping create opportunities to increase efficiencies, productivity and income. It has been estimated that the rollout of 4G networks alone will provide a £75bn boost to the UK economy.[10] And recent research by the CBI found that 81 per cent of firms see more reliable mobile connectivity as essential.[11] Mobile telecoms is also a major British industry in its own right, with the four largest mobile network operators providing over 35,000 FTE jobs, and supporting some 140,000 UK jobs overall, contributing £4.5 billion per annum to national economic output.[12]

The evolution of mobile communications

1.3 Given its current prevalence and significance, it can be surprising to reflect on how recently mobile telecoms technology emerged. The first public service for a mobile telephone was in Japan in 1979, which was followed by the introduction of the 'Nordic Mobile Telephone' in Europe. In 1983, the first commercial services were introduced by Motorola in the USA.[13] Cellular networks were first deployed in the UK by Vodafone and BT Cellnet in 1985, inaugurating the first generation of mobile systems.[14]

1.4 The development of mobile communications has, from the beginning, been an evolutionary process, with each generation of mobile standards introducing improvements in quality and functionality. In the early 1980s, the first mobile generation, or 1G, introduced a niche service to a limited number of subscribers, which allowed for analogue transmission using the electromagnetic spectrum to send 'voice' in essentially the same way as any two-way radio.

1.5 The second generation of mobile, 2G, was introduced in the early 1990s and was characterised by adoption of digital transmission and switching technology, which increased the capacity and efficiency of networks and also allowed for the introduction of some early data services, with the first text (SMS) messages sent in sent in Finland in 1993.[15]

1.6 Although 2G networks created a step change in the global number of subscribers, it was not until the advent of 3G in 2003 that data services became a core part of mobile phone use.[16] This drove the adoption of the mobile internet, with data rates and speeds steadily improving through the development of various new technologies (sometimes referred to as 3.5G) and allowing for streaming of audio and video.[17]

What is Machine to Machine and The Internet of Things?

Machine-to-Machine, or M2M, is a connection between devices, often wireless, where human input is not necessarily required. For example, smart electricity and gas meters, which use a SIM to report energy usage data for billing purposes.

The Internet of Things (IoT) is a broader term for the creation of new and innovative services by the interconnection of everyday devices, often using M2M connections. M2M and the IoT are not reliant on a specific mobile generation – in fact 2G technology provides sufficient bandwidth and connection speed in many instances – but connected devices are predicted to grow exponentially across the coming decades, which will place growing demands on the capability of the UK's networks.

1.7 The transition to 4G services, seen in the UK since 2012, has provided users with access to considerably faster data speeds and lower latency (or 'lag'), and given rise to the proliferation of the manifold new applications that are increasingly taken for granted in the smart phone age. This has resulted in an enormous increase in data usage per user as streaming of services such as HD video becomes commonplace. Data demand increased by 53 per cent in the UK in 2014 alone.[18]

1.8 As well as improving the connectivity of individual users, advances in mobile technology have also resulted in the emergence of devices connected over the internet, known as the Internet of Things (IoT). Although still at a nascent stage, there are already some 6 million connected devices in the UK.[19] This figure is predicted to increase rapidly with, for example, energy suppliers committed to installing around 50 million gas and electricity smart meters to all homes and small businesses by the end of 2020.[20]

1.9 The potential for connected devices is vast, and has already led to the emergence of wearable sensors for people with serious health conditions as well as developments in many other sectors, from logistics through to agriculture.[21]

Figure 1: Features of the mobile generations

Generation	Primary Services	Key differentiator	Weakness (addressed by subsequent generation)
1G	Anologue phone calls	Mobility	Poor spectral efficiency, major security issues
2G	Digital phone calls and messaging	Secure, mass adoption	Limited data rates – difficult to support demand for internet/e-mail
3G	Phone calls, messaging, data	Better internet experience	Real performance failed to match hype, failure of WAP for internet access
3.5G	Phone calls, messaging, broadband data	Broadband internet, applications	Tied to legacy, mobile specific architecture and protocols
4G	All-IP services (including voice, messaging)	Faster broadband internet, lower latency	
5G	Enhanced mobile broadband, Massive Machine type communications/IoT, critical communications	Ultra-fast, low latency and reliable connectivity giving the sense of ubiquitous coverage. Enabling numerous new benefits across a range of industrial sectors	

The UK mobile ecosystem

1.10 Over the last decade, the UK mobile market has undergone a number of significant changes reflecting developments in technology, demand for services and market maturation. Since the 2010 merger between T-Mobile and Orange there have been four UK Mobile Network Operators (MNOs) which own and maintain mobile networks and licenced spectrum.

Figure 2: UK Mobile Network Operators and share of subscribers

Operator	Subscribers including MVNOs (%)	Ownership	Network Sharing	Active Infrastructure	Passive Infrastructure
BT/EE	33	BT Group	MBNL	Operator retains ownership. Operational responsibility for 3G network with MBNL.	Operator retains ownership. MBNL manages sites.
Three	11	Hutchison			
O2	33	Telefonica	CTIL	Operator retains ownership. Operational responsibility split geographically. Vodafone West, O2 East.	CTIL owns passive assets. CTIL Manages sites.
Vodafone	23	Vodafone			

Source: Analysis Mason Data (note: "active" describes antenna and related radio equipment, "passive" enables the active infrastructure to operate, e.g., masts and power supply.)

1.11 In recent years network sharing agreements have been established by the MNOs through joint ventures between EE and Three (MBNL), and O2 and Vodafone (CTIL). This marks a departure from the previous model of vertical integration and is widely seen to have reduced the fixed costs of network deployment, operation and upgrade and also to have improved coverage.

1.12 At the network-supply level, access to cell sites is increasingly controlled through third party providers known as Wholesale Infrastructure Providers (WIPs). Both MBNL and CTIL utilise third party sites for locating mobile network equipment. In the UK the largest WIP is Arqiva, which has some 16,000 sites including 8,000 active cellular sites in the UK.[22] Wireless Infrastructure Group are also very active in the wholesale market, owning more than 2,000 shared communication infrastructure assets and providing independent infrastructure aimed at delivering improved, smart city connectivity. Use of WIPs results in cost savings for MNOs through economies of scale in a similar way to network sharing, indeed, industry analysis suggests that use of WIPs can save as much as 50 per cent of costs in some circumstances. As a result the need for increased infrastructure sharing has been highlighted as central to delivering future networks efficiently and effectively.[23]

1.13 An important feature of today's mobile market is that customers are no longer constrained to use only the services provided by their MNO. The internet is an open platform, and access to it via smart phones has led to the development of parallel customer relationships between end-users and new ("over-the-top") application providers, such as Facebook, Google and Netflix, increasing demand for mobile data. These applications have also enabled the growing substitution of traditional mobile services, including voice calls and SMS texting, by comparable services offered through web-based applications such as WhatsApp and Skype. Taken as a whole, the changes seen in the mobile market have increased complexity considerably.

Mobile Virtual Network Operators

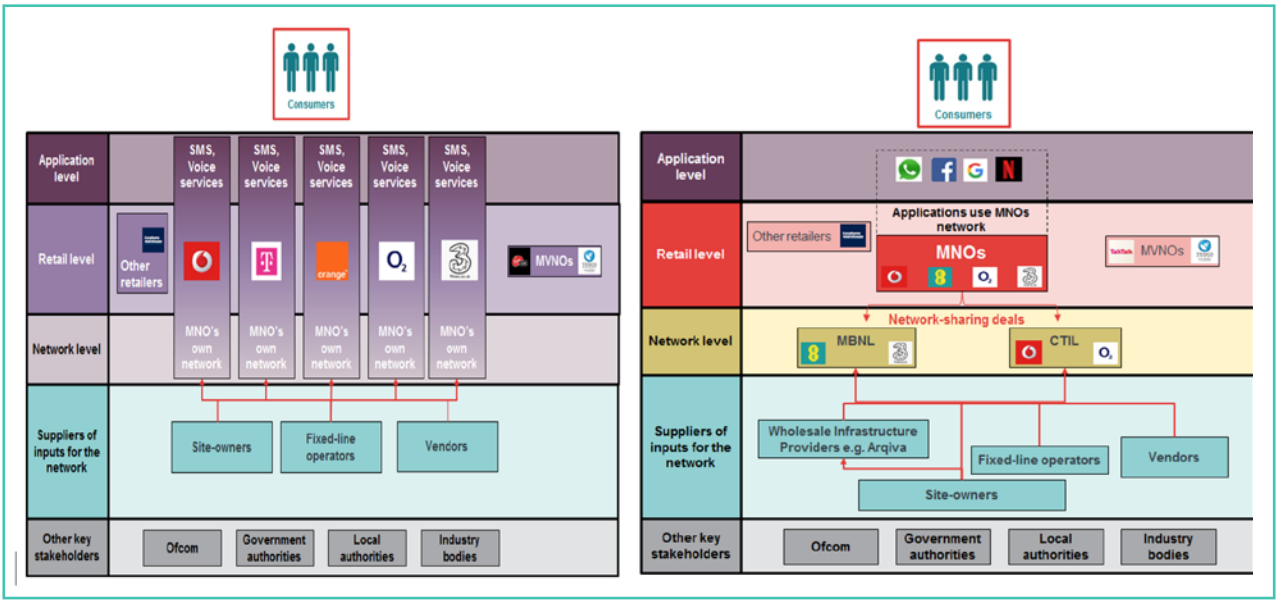
Mobile Virtual Network Operators (MVNOs), offer services similar to a mobile network operator (MNO), but MVNOs do not own the infrastructure or radio frequency spectrum. Instead, MVNOs enter into agreements with MNOs which then provide access to spare infrastructure capacity and spectrum. Depending on the type of MVNO, it will either buy bulk access to the network services from the MNO at discounted rates and then set its own proposition and retail prices, or it will enter into a reseller agreement with the MNO. MVNOs help to foster competition in the market by providing more diverse customer products and services. In the UK, MVNOs hold a combined 15% of total subscribers. The largest UK MVNO is provided by Tesco, which has over 3.5 million customers and runs on O2 infrastructure.

1.14 However, whilst significantly changed, the UK mobile market has remained competitive. Four MNOs still play a central role in network investment and seventeen Mobile Virtual Network Operators (MVNOs) are active,[24] helping foster competition. As a result, consumers have enjoyed innovative services and pricing in recent years, such as unlimited internet data, and UK prices are among the lowest in Europe, with the cost of a typical package falling by two-thirds since 2003.[25]

1.15 Following some years of declining revenues, the UK mobile market appears to have stabilised, with total telecoms revenue growing by £0.2bn (0.5%) to £37.5bn, and UK mobile companies generating some £15bn in revenue.[26] At the end of 2015, UK mobile subscriptions had reached 91.5 million and were continuing to grow.

1.16 Rapid advances in mobile device technology have also impacted the mobile ecosystem profoundly. Smartphones and tablets have been phenomenally popular with consumers, and have transformed how we communicate and consume media. This, in tandem with the launch of 4G, has been a further factor driving the very significant data usage increases seen over recent years. The graph below shows recent and predicted increases in global data usage; a similar pattern of growth has been seen and is forecast in the UK.

Figure 3: Changes to the mobile telecoms market, 2005 – present



1.17 In the UK, MNOs have invested billions in 4G network deployment, and "by the end of 2015, 39.5 million mobile connections could access 4G services, an increase of 15.9 million compared to the previous year, equivalent to 46 per cent of all UK mobile connections (excluding Machine to Machine connections), an 18 percentage point increase".[27]

What is 4G?

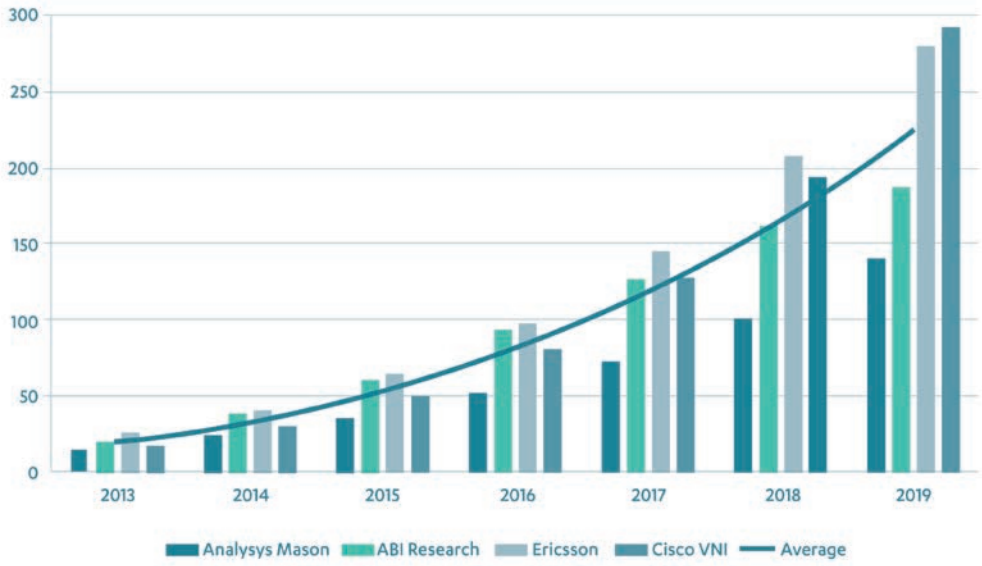
4G stands for the 4th generation mobile communications standard. It allows internet access at higher speeds than previous standards. All premium smartphones can use 4G services, but are still compatible with previous (2G/3G) standards. The first commercial 4G service was launched in the UK in Oct 2012 by EE, and the auction for 4G spectrum ended in Feb 2013, with EE, Telefonica (O2), Vodafone, Three and Niche Spectrum Ventures Ltd (a BT Group subsidiary) receiving licences. Vodafone and Telefonica launched their 4G services in August 2013, and Three followed in 2013 (London) and 2014 (nationwide). Voice over 4G networks is now being deployed across the UK.

1.18 However, it is notable that the majority of traffic to mobile devices is now delivered over fixed line Wi-Fi networks, with this share predicted to grow further.

1.19 As data consumption over mobile devices has increased, there has been a corresponding decline in use of a number of more traditional telecoms services. Fixed home lines and fixed voice call minutes fell by seven billion minutes (9.2%) in 2015.[28] And traditional mobile messaging (SMS/MMS) has declined for three consecutive years due to the rise of substitute services such as WhatsApp and Facebook messenger.

Figure 4: Industry forecasts of global mobile data traffic

Traffic in exabytes



How do mobile networks function?

1.20 In order to allow tens of millions of people across the UK to make calls, send texts and access mobile broadband services, each of the four MNOs divides the UK into thousands of individual geographic areas known as 'cells'. At the heart of each cell is a fixed-location base station. Mobile phones access the mobile network by sending and receiving data from a nearby base station, and switch from one cell to another as the mobile device user travels and reaches what is called the 'cell edge'.

1.21 The UK mobile network is extensive with the four MNOs utilising some 40,000 base station sites to provide mobile coverage, and each utilising their own 'core fibre' fixed network as well as using fibre connectivity from third parties such as BT. The UK's four MNOs operate under a licence which grants them access to specific radio spectrum, although network share agreements and use of third party owned sites play an increasingly important role. How the mobile network functions is outlined below:

Figure 5: A roof mounted macro cell base station, a mast mounted macro cell base station, and an EE small cell mounted on a lamppost.

There are currently 40,000 base station sites across the UK. The denser network required for 5G will require many more.



Mobile network infrastructure

Mobile network infrastructure can be divided into three main elements:

- The **radio access network**: the network of base stations providing cellular coverage across the UK to transmit and receive data from mobile devices such as smart phones.
- The **backhaul network**: the network which relays data from the base stations to the operator's core network. Backhaul can be over physical cabling, such as fibre or over wireless microwave links – often used in more remote areas. MNOs therefore use a combination of microwave and physical backhaul, with fibre now preferred where possible due to its ability to carry high capacity data. In some cases fixed-line operators (e.g. BT and Virgin) provide the links necessary to connect different parts of the MNO's network and in other cases MNOs provide these links themselves.
- The **core network**: the "intelligent" part of the network owned by each MNO, which identifies where the network's subscribers are and ensures that data is sent to the correct user. It also provides the link to other networks, such as the other mobile networks and fixed networks for calls or the Internet.

Base Stations

Base stations send and receive mobile voice or data information. They vary in size and cost, but each requires an appropriate site with a power supply and, generally, a fibre connection. The decision about which type to install on any given site depends on the coverage area required and the service – in terms of data speeds/quality – to be delivered. Mobile networks are essentially comprised of four types of base station, known as:

- **Macrocells**, which provide the main radio coverage for a mobile network. Antennas for macrocells are mounted on ground-based masts, rooftops and other existing structures.
- **Microcells**, which provide infill radio coverage and additional capacity where there are high numbers of users within urban and suburban macrocells. The antennas for microcells are mounted at street level (i.e. below the surrounding buildings and terrain) typically on the external walls of existing structures, lamp-posts and other street furniture.
- **Picocells**, which provide more localised coverage than microcells (e.g., inside buildings) where coverage is poor or there are high numbers of users
- **Femtocells** which are more commonly installed by home or small business owners as opposed to traditional mobile network operators.

Spectrum

The radio spectrum is part of the electromagnetic spectrum, and is widely used for modern day telecommunications, broadcast TV and radio. Information can be transmitted over different frequency bands within the radio spectrum, broader bands enabling more data to be transferred. The radio spectrum is a finite resource and so bands are allocated to users such as the mobile operators by Ofcom to ensure the spectrum is efficiently used and to avoid interference between users. Different frequency bands have different characteristics with lower frequencies providing better wide area coverage and building penetration and higher frequencies offering better capacity, but over shorter distances. A mixture of high and low frequency bands are therefore needed by mobile operators and used at each base station to provide services.

MNOs currently hold spectrum licenses to operate in the 800MHz, 900MHz, 1,800MHz 2,100MHz and 2,600MHz bands, although each operator has different exact spectrum holdings. Not all spectrum is licensed; WiFi networks use shared 2.4GHz and 5GHz frequency bands, with each band offering a trade-off between capacity and coverage.

Coverage

Mobile voice coverage is provided by MNOs using a combination of 2G and 3G technologies with mobile data coverage provided over 3G and 4G. In February 2015, Ofcom varied the licences of the UK's four MNOs to commit them to providing 90% geographic coverage for voice calls by the end of 2017. Ofcom's 4G auction was designed so that one licence – acquired by O2 – has to roll out 4G to cover at least 98% of the UK population by 2017 at the latest, with market forces pushing the other MNOs to follow suit. Additional sites are being deployed to meet these commitments and to achieve an improvement in data coverage to 98% of premises. As part of the UK Government's new Emergency Services Mobile Communications Programme, EE will be building more than 500 additional 4G sites which will have the additional benefit of providing increased coverage for their mobile customers.

UK COVERAGE FOR MOBILE VOICE SERVICES, BASED ON COMBINED 2G AND 3G COVERAGE

	O2	Vodafone	EE	Three
Outdoor coverage				
Premises	98%	98%	99%	98%
Geographic	72%	77%	78%	68%
Indoor/In-car* coverage				
Premises	93%	92%	94%	93%
Motorways	97%	97%	99%	98%
A & B Roads	67%	73%	81%	73%

UK COVERAGE FOR MOBILE DATA SERVICES, BASED ON COMBINED 3G AND 4G COVERAGE

	O2	Vodafone	EE	Three
Outdoor coverage				
Premises	92%	92%	98%	98%
Geographic	47%	49%	75%	68%
Indoor/In-car* coverage				
Premises	86%	83%	94%	93%
Motorways	83%	83%	99%	98%
A & B Roads	49%	48%	79%	73%

*For in-car coverage we assume that the phone is used within the vehicle. Coverage would be better if a car kit with an external antenna were used.

Source: Ofcom analysis of operator data

Although coverage data provides a good indication of the reach of mobile voice and data services, the picture is incomplete in terms of mobile user experience. For example, a study this year by Which? and independent mobile coverage experts OpenSignal found that mobile customers in the UK were able to access 4G just 53% of the time on average. This suggests that network availability from a user perspective is lower than that set out in coverage statistics. Coverage on our transport networks is often poor. The RAC foundation found that c. 4,600 miles of British roads have no 2G mobile phone coverage from any network provider – the minimum coverage required to make a call – and that over half of the entire road network had no 4G coverage. The situation is similarly poor on the railways with rail passengers frequently unable to make voice calls, utilise SMS messaging or send and receive mobile data due to poor coverage across the rail network.

Future mobile networks

1.22 Each successive mobile generation has given rise to an ever larger number of users, uses and applications. The impact has been profound, with mobile connectivity often now described as a utility rather than a luxury. This pattern is set to continue as mobile markets adapt and 5G technologies are introduced. Against this context, it will be vital for mobile networks to be deployed and available in the places and with the capability that people and businesses require.

1.23 In order to help inform a sense of how the UK's mobile networks are likely to evolve across the next decade and beyond, it is instructive to consider the factors which will influence this together with lessons from previous network deployments. A central factor will be the way in which network providers respond to the future demands of society and the economy for mobile services.

Evolution or revolution?

1.24 A common feature across all previous mobile generations – and one which is likely to continue – is the evolutionary nature of both technological improvement and mobile network deployment. The next mobile generation – 5G – is widely predicted to mark a step change in digital communications, but it will take time for business models for new mobile services to develop, for networks to be rolled out and for new technologies to be tested and brought to market. Despite a great deal of speculation and enthusiasm about the possibilities, 5G is still at an early stage with primary research ongoing and standards not yet set. There is not yet a universally agreed definition of what 5G will encompass.

1.25 A number of questions therefore remain to be addressed. For example, there is uncertainty about the extent to which the market will be willing and able to invest at scale in capital intensive 5G networks, particularly in less populated areas.[29] There is also uncertainty about which future mobile services will take off and drive demand for 5G and whether it will be possible to monetise such services.

Potential scale of 5G benefits

Determining the scale of 5G benefits is necessarily speculative. However, a 2016 EU study estimates that in 2025 benefits from the introduction of 5G capabilities could reach €113.1 billion per year in four key sectors which will be the first users of 5G connectivity: automotive, health, transport and energy. Investments of approximately €56.6 billion will be likely to create 2.3 million jobs in Europe.

1.26 Nevertheless, over time 5G is seen as likely to change the way people, institutions and objects interact in a number of ways. This could have profound implications for society. It is expected that, as and where 5G networks are deployed, there will be ultra-fast connectivity and the perception of virtually ubiquitous broadband capacity, not only to individual users but also to connected objects, supporting a wide range of advanced technologies. 5G is expected to facilitate a wide range of new services to diverse sectors, such as: smart cities, eHealth, energy management, cloud computing, augmented and virtual reality, autonomous vehicles, online gaming, and enhanced mobile broadband. It is also considered to be an underpinning technology for the 'Internet of Things'. Taken together, these services and applications are expected over the course of the next two decades to require a combination of higher data download and faster data upload speeds, lower latency (lag) and greater on the move accessibility.

1.27 5G will not be a single network akin to the first 2G deployments in the UK. Instead it is expected that we will see the convergence of existing mobile generations and fixed networks, and see the introduction of evolved versions of 4G, before 5G technologies emerge. As technologies develop further over time, millimetre wave ("MMWaves") cells using extremely high frequency radio spectrum are expected to begin to be utilised, mainly in densely populated areas, in order to provide a response to the low latency and high bandwidth demands predicted of future services. This will require an increased number of macro cells and – if predictions are correct – an order of magnitude increase in small cells, each using a range of mobile technologies. These new cells will require a power supply and, in most cases, a fibre link. Given the large proportion of mobile data consumed over Wi-Fi – some 80% today – it seems highly likely that Wi-Fi will continue to play a significant role in the future, in the home and workplace as well as in many public spaces.

1.28 Mobile infrastructure in the UK is already expanding, driven by market forces and government intervention, in order to try to meet existing user needs. But with demand for ubiquitous coverage and higher data rates set to increase markedly, there are urgent questions to consider about how best the market, regulators and government should respond.

Over time 5G is seen as likely to change the way people, institutions and objects interact in a number of ways.

Factors that will influence future mobile network deployment

1.29 The mobile market has seen significant change over time, from an industry previously dominated by five vertically integrated MNOs, to the current multi player ecosystem which includes bodies such as: MNOs, MVNOs, WIPs, and an increasing number of 'Over the Top' content providers, such as Netflix, Skype and Google.

1.30 Adding to this complex picture are a number of (known) pressures facing the mobile telecoms industry which will continue to provide challenges across the next decade and beyond. How the industry responds will go a long way to determining the nature of the services users can expect to readily access. Key among these challenges are capacity and coverage which are explored below:

Capacity of networks

Mobile networks have evolved to deliver increasingly sophisticated services to growing numbers of subscribers. As smart phones and tablets have proliferated, a phenomenon known as the "capacity crunch" has emerged, which is characterised by a scarcity of spectrum and mobile network infrastructure in areas where demand for mobile services is high. This is a result of significant growth in user data rates, which spiked dramatically following the launch of the iPhone in 2008, and the associated increase in 'media rich' data based applications for mobile devises. This growth trend is predicted to continue with a six fold increase expected on mobile traffic in Western Europe between 2015 – 2020 which poses questions about the ability for existing mobile infrastructure to accommodate anticipated demand. Most additional data is likely be consumed in densely populated areas, although busy transport networks will also see an increased capacity requirement. In the past, data capacity/traffic growth has been served through a combination of greater spectral efficiency and the allocation of increased amounts of prime spectrum for mobile communications. However the ability of technology to carry more data over spectrum bands is becoming limited, as is the availability of evermore suitable spectrum bands for deployment on traditional macro cell networks since this has already been allocated.

The combination of these factors means that additional 'small cell' base stations will be required using higher frequency spectrum, meaning significant new deployments of infrastructure are necessary.

An emerging tension in the UK mobile market – likely to exacerbate the capacity crunch – is limited capital. Data usage has grown exponentially over recent years, but the UK mobile market has been unable to increase revenues by passing on costs of this to consumers, leading to challenges in financing the enhancement and deployment of capital intensive networks. Therefore, whilst competition in the market would be expected to lead to a degree of additional network deployment over the next 10 – 15 years, limited private capital within the market and previous difficulties seen in monetising data usage suggest that this is likely to be limited to the most economic (generally dense urban) areas.

Coverage across the UK

As mobile communications becomes increasingly embedded in everyday life, there is an implicit expectation of ubiquitous coverage, indeed, 100 per cent reliability and ubiquitous coverage have been described as potential features of 5G. However, gaps exist across each mobile generation in terms of coverage today, which demonstrates the limitations of competition to deliver ubiquity. This is due to a combination of factors, including regulatory and planning constraints, together with the costs and dynamics of deploying mobile networks. This has led to government intervention, such as service obligations, through Ofcom. But despite these measures, there are still areas with no mobile coverage from any operators (complete not spots), as well as where only some operators provide coverage (partial not spots). Though many of these coverage gaps are in rural areas, as has been seen, they also exist on our transport networks. Inadequate geographic coverage affects users now and, if allowed to continue, will likely hinder the deployment of a number of innovative applications. Although developments in the medium term – such as the completion of the roll out of 4G networks and NMO licence obligations requiring 90% geographic coverage for voice calls by the end of 2017 – will bring some improvement, it is likely that there will continue to be ongoing coverage issues unless further action is taken.

What will future networks be used for?

1.31 Accurately predicting all of the services and applications that will emerge as a result of improved mobile networks in the future is impossible. The impact that the introduction of smart mobile devices has had on how we function as a society has been unprecedented, but it was not predicted in advance.

1.32 Nevertheless, recent research suggests that there are several possible broad use cases for future mobile networks which appear credible over the near to mid-term.[30] By examining a group of broadly representative potential use cases – which consequently place representative demands on network requirements – it is possible to begin to illustrate how 5G might evolve.

1.33 At the global and European levels, efforts to begin to standardise 5G – due to be finalised in 2019 – have led to the identification of three key, high level service areas. These are:

- **Enhanced mobile broadband** could enable a plethora of media rich services, such as continual, low latency and high speed access to cloud services and applications: real time augmented reality and AI assistance permeating into more and more aspects of our daily work and social lives, as well as nearer term examples such as advanced gaming. Increased demand for mobile broadband has been exponential as mobile subscribers continue consume data hungry services. Demands for adequate quality of experience are already driving the need for the densification of network infrastructure and placing demands on spectrum. Data rates for services are now, and will continue to be, important for mobile broadband services. But, increasingly, the ability to offer a consistent quality of experience will come to the fore.

- **Massive machine type communications** is chiefly concerned with the consolidation of machine to machine communications into a single enabling infrastructure, such as 5G, necessary to enable the rapid increase in numbers of connected devices in coming years. Many of these devices will be low cost, specialised sensors transmitting relatively small data volumes, often intermittently. A number of potential smart city functions are underpinned by massive machine type communication, such as energy usage and transport management. Emerging technologies employing machine to machine type communications have the potential to radically improve the way we manage our infrastructure in the UK.

- **Ultra-reliable and low latency communication** is expected to be required for the control of machinery, for example in highly automated factories and for management of mission critical assets, for example, in the utilities industry. It necessitates mobile cells in close proximity to the end user/devices, for example, at the roadside or within an automated factory, in order to reduce latency.

1.34 Research conducted for the NIC has helped to identify emerging areas of interest within the UK. These are:

- Connected and autonomous vehicles
- Mobile media and cloud
- Railway connectivity
- Healthcare
- Smart utilities
- Supply chain and logistics

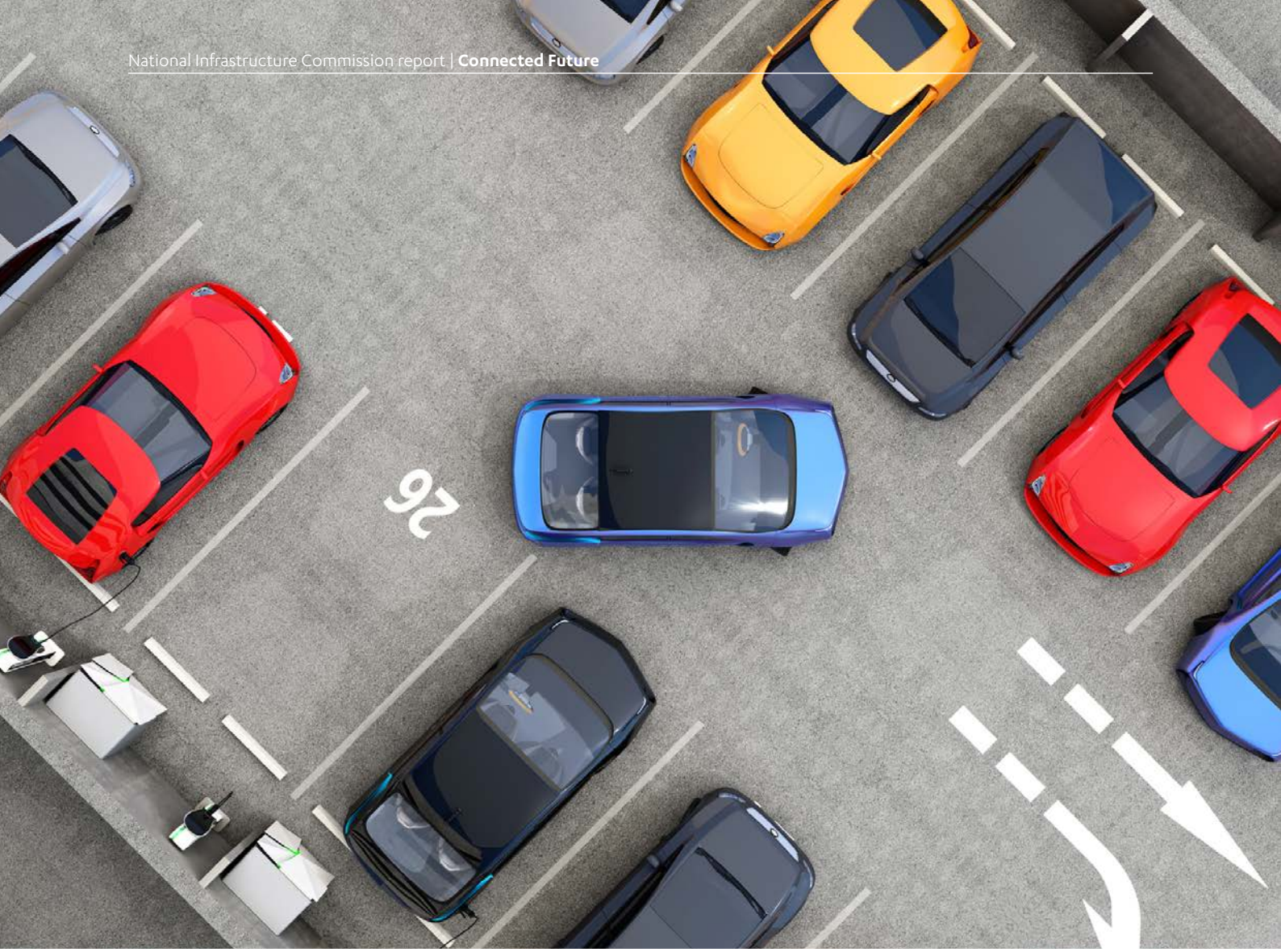
1.35 Whilst there is still uncertainty about how future mobile services will develop over time, the areas identified above – whilst by no means exhaustive – appear credible on the basis of the process of industry liaison undertaken to inform this study. Importantly, they also give broad coverage for a range of other uses that could emerge. By considering the infrastructure implications for these representative nascent and more foreseeable uses, it is also possible to consider future mobile network requirements which are likely to encompass services that will be harder to foresee.[31]

Connected and autonomous vehicles

1.36 Connected and autonomous vehicles (CAVs) have been described as the next 'mobile device' beyond the current generation of smart phones, tablets and emerging wearable devices. Mobile service providers and vehicle and component manufacturers have all identified features which either rely on or benefit from increased connectivity; indeed, the industry has expressed concern that poor existing mobile coverage is slowing the mass market entry of increasingly connected vehicles.

1.37 The potential benefits of CAVs are very significant, with recent research suggesting a value of £51 billion per year to the UK economy by 2030.[32] The enabling infrastructure to support the introduction of sophisticated, highly connected and increasingly autonomous vehicles is, therefore, of real significance to the automotive industry and wider society.

1.38 CAVs are likely to operate through a combination of technologies. On-board intelligence through radar/sensors and processing will be required to take decisions in milliseconds about collision avoidance, for example. Such systems are unlikely to be reliant on external communications networks. However, to achieve the full benefits from these technologies, connectivity that incorporates both vehicle to vehicle and vehicle to infrastructure systems will be needed. Roadside small cell beacons, transmitting and receiving data, will deliver a rapid and reliable data feed, which will enhance operational capability and provide information, for example, about congestion, lane closure and adverse weather, as well as a general internet connection for entertainment and vehicle management purposes.



Connected and autonomous vehicles network needs

Connected and Autonomous Vehicles (CAVs) suggest three distinct, though linked, future network use cases for:

Driver assistance – sometimes known as advanced driver assistance (ADA), this uses on board sensors and connections to other vehicles and back office systems to improve safety as well as reduce congestion. Vehicle to vehicle and vehicle to infrastructure connections provide better control to road operators as well as enhancing on board sensing capabilities, for example receiving data that a vehicle in front is stationary. ADA is time critical and therefore requires low latency and certainty of communication.

In vehicle connectivity – provides access to entertainment as well as general in-car connectivity. Typically, an in built Wi-Fi access point in the vehicle supports several devices and applications simultaneously. This use could place large data demands on networks.

Vehicle management – provides a variety of services, such as data feed to manufacturers regarding the performance of their vehicles and the parts/sub systems in them, as well as identifying vehicle faults in advance. Vehicle management is essentially a machine to machine application with a relatively low data requirement.

1.39 In the near term, roadside connectivity could be provided using a range of technologies, such as Dedicated Short Range Communications (DSRC), a short- to medium-range wireless communication channel. And, as 5G technologies come to market, they are likely to be well suited to rapid, high capacity roadside connectivity.

1.40 There is still uncertainty about precisely how, where and when CAVs will come into mass operation, though full automation is not considered likely until beyond 2030.[33] However, the process is already underway, with features such as on-board Wi-Fi and increasing degrees of driver assistance (such as autonomous parking and braking) included in vehicles already on the market. And the Department for Transport, Transport for London, Kent County Council and Highways England are moving towards deployment of an extensive connected corridor trial on stretches of road including the A2 and M2, which will utilise roadside connectivity infrastructure.

1.41 Before the end point of fully autonomous vehicles is reached, there are significant potential benefits for motorists and wider society to be captured through increasing levels of vehicle connectivity and autonomy. For example, the platooning of vehicles will increase efficiency, advanced driver assistance will reduce error, and real time data connectivity will notify the vehicle and driver of accidents and congestion ahead. As a result, supporting the development of CAVs through provision of enabling infrastructure must be a priority.

1.42 As has been described, there are existing mobile connectivity challenges on UK roads, both strategic and local. Therefore, a critical challenge to be overcome in order to facilitate the entry of CAVs will be the provision of high quality and ubiquitous roadside coverage. To achieve this on UK roads a substantial amount of additional infrastructure will be required. In thinking about deployment of infrastructure to enable communications between cars and infrastructure it is clearly important to consider whether this infrastructure can also be used for passenger communication needs. These issues are explored in more detail in part 2.

Mobile media and cloud Services

1.43 The media and cloud sectors have been transformed in the past 15 years by high speed connectivity and a widening range of smart devices, particularly smart phones.[34] The rising consumption of services such as Netflix and cloud based content, as well as the changing pattern of broadcast TV consumption have created new businesses and opportunities in the UK, as well as challenging established players.

1.44 Media and cloud services are already increasing network demands. For example, there has been significant growth in consumption of video through mobile devices, and the rise in immersive gaming.People are increasingly making use of massive cloud based processing from our smartphones transparently to achieve tasks that were computationally impossible a decade ago – for example through the AI based speech recognition and assistance embedded in many Apple and Android devices. This pattern is set to continue for the foreseeable future as opportunities for entertainment on the move, digital advertising and pay-TV business models are further exploited.

Cloud computing market is predicted to be worth some ***£13 billion*** *by the end of 2016 and* ***84% of UK companies*** *used hosted cloud services in 2015.*

1.45 Demand for increased worker and business efficiency will also place increased demands on mobile networks. Cloud services are an area of high growth in the UK; the cloud computing market is predicted to be worth some £13 billion by the end of 2016 and 84% of UK companies used hosted cloud services in 2015. Collaborative working platforms using features such as conferencing, cloud based productivity apps and storage, currently present a relatively low peak rate data demand, partly due to the prevalence for mobile data carried over Wi-Fi (some 80% today). However, across the next decade and beyond, the cumulative device density is likely to have a significant impact on mobile infrastructure capacity in densely populated areas and potentially outside urban centres. Given the importance of business efficiency while travelling, this also poses questions about mobile coverage and capacity on transport networks.

1.46 The use of mobile media and cloud-based services will continue to evolve over time as consumers become accustomed to the new opportunities offered, network capacities increase and users acquire supporting devices. By 2019, video over mobile is expected to account for 80 per cent of worldwide mobile traffic, with the rise of next generation ultra-high resolution video – "4K" – expected to contribute in increasing this further, particularly if mobile users choose to record and share 4K videos in large numbers.

1.47 Taken as a whole, the potential UK benefits through mobile media and cloud services appear very significant due to the size of cloud driven business as well as that of the TV and gaming industries. The UK gaming industry was worth some £4.2 billion in consumer spend in 2015 and the UK TV industry generated £13.2 billion in revenue in 2014. In terms of advertising revenues, mobile is driving the highest levels of growth in the digital sector, with mobile having overtaken desktop for the first time and now accounting for 51% of total ad display. But continuing growth relies on new and improved services, which in turn will rely on improved networks.

Railways

1.48 Demand for rail travel in the UK has shown consistent growth over recent decades, with passenger numbers more than doubling since 1996/97, and some 1.7 billion passenger journeys made by rail last year. However, mobile coverage on the UK's 19,000 miles of railways is notoriously poor. The Government has already made clear its desire to improve mobile connectivity for rail passengers[35] as well as its ambitions for utilising digital services for improved rail operations. And the demand for mobile broadband on trains is evident, with mobile connectivity regarded as a top ten issue by passengers.[36]

1.49 The benefits to be derived through improved trackside connectivity could be very large, potentially increasing passenger efficiency, productivity and recreation and providing the connectivity required to enable a digital railway to function effectively. It could also facilitate the introduction of a number of IoT applications, for example supporting railway and rolling stock maintenance. Currently, however, rail passengers are mostly reliant on cellular coverage. Due to the difficult geography of cuttings, tunnels and rural routes, this often amounts to a very substandard level of connectivity.

1.50 The Government is committed through the franchise process to making Train Operating Companies (TOCs) accountable for the provision of in carriage Wi-Fi. It has set passenger connectivity targets to be met by TOCs, which will incorporated into new franchises as these are renewed (although the renewal process will not be completed until 2028).

1.51 There are questions about whether this approach will provide future-proof connectivity for passengers and meet the potential connectivity requirements of future digital rail operations. These issues are explored in more detail in part 2.

The health sector

1.52 New technologies, enabled by wireless networks, could be transformational to the healthcare sector. Both the Department of Health and NHS have identified the better use of data and technology as priorities with "the power to improve health, transforming the quality and reducing the cost of health and care services".[37]

1.53 A number of trials are underway with the aim of harnessing technology to address some of the most complex issues facing patients and the UK health service,[38] which is under pressure due to an increasing and ageing population as well as a rise in chronic conditions.[39]

1.54 This backdrop has led to high interest and growth in digital healthcare services which can potentially replace or complement physical resources and provide improved efficiencies and cost savings. Broadly, digital healthcare services can be categorised as:

- **Preventative health services** – are based on health monitoring via a connected mobile device, managed by the consumer rather than a healthcare provider. These applications are often smartphone based but in future will likely encompass wearables able to provide more detailed data. Such technologies can, for example, monitor heart rate, blood pressure and sugar levels. Given the increase in lifestyle related health issues in the UK, preventative health represents a central goal in UK health policy, enabling patients to take more control of conditions, lifestyle and fitness. The potential market is large and hence associated benefits in terms of better health outcomes and reducing burdens on the NHS could be very significant. There is also the opportunity to use the data generated for preventative purposes by enabling data-driven analysis of nationwide health trends.

- **Assisted living services** – are a form of health monitoring managed and monitored remotely by a healthcare provider, social care provider or family member. The aim is to decrease the amount of time that individuals with health conditions spend in hospitals and care homes and increase the time they can stay in their home. Sensors around the home can provide information about a person's movements, raising alerts to any unusual behaviour, and wearables (body sensors) can enable health monitoring outside the hospital for those who would not use a smartphone app or where such an app would be insufficiently sophisticated. Given the UK's ageing population, there are clear social and economic benefits from enabling higher levels of assisted living in the home.

- **Remote healthcare services** – includes patients consulting with their GPs remotely via a fixed or mobile internet link, and also the potential for subsequent monitoring on an ongoing basis. This could be achieved through, for example, smartphone apps, wearables or body-based sensors depending on the symptoms to be monitored and could be particularly beneficial to patients in remote areas and/or with limited mobility. The consultation experience could potentially be made more realistic with virtual reality and diagnostics could make use of artificial intelligence engines to improve accuracy. Applications of these kinds could enable a significant area of health service activity to be delivered more effectively, with more convenience and at lower cost.[40]

NHS diabetes digital coach

Diabetes digital coach is a two-year Internet of Things 'test bed' programme led by the West of England Academic Health Science Network.

It will recruit 12,000 people with diabetes across the region to test and evaluate a wide range of innovative technologies to help in the self-management of their condition. Individuals with diabetes will gain a comprehensive, real-time view of their own data, which will inform self-management strategies which they can share with relevant healthcare professionals, who will then be better able to prioritise the needs.

The project subsequently intends to aggregate data, information and knowledge to gain a real-time (as opposed to historic) and population-wide view of the health status of people with diabetes to promote behaviours to improve health.

1.55 Each of these healthcare uses seem likely to be most heavily utilised in indoor environments, for example, home sensors and patient monitoring devices connecting via a local area network or via a broadband access point at the home (e.g. Wi-Fi). Therefore, ensuring all of the population have access to either mobile or fixed line broadband services is likely to be the key near term requirement to support remote health services. But to deliver the fullest benefits over the longer term wider monitoring capability including in external environments will be needed.

1.56 Many monitoring products, such as smart insulin pens and smart inhalers, either currently available or planned, are commonly tethered to mobile devices for data upload back to central servers. This requirement is unlikely to put significant strain on the UK's mobile networks in the near term, because the data throughputs and volume of data from each monitoring device are small and a lot of the data traffic may be offloaded through indoor networks, but it does raise questions about ubiquitous coverage.

1.57 Over time, machine type communications supporting massive densities of patient sensors are seen by many as a key requirement for future 5G mobile networks offering those with long term conditions freedom from hospitals and care centres for longer, and reducing burdens on the NHS as a result. As noted above, although much of the data traffic is likely to be carried on indoor networks (such as Wi-Fi), where connectivity is required on the move or where mobile networks are providing "last mile" broadband connectivity – for example through radio links to rural premises – then high quality, reliable mobile networks become critical.

1.58 This suggests that UK wide coverage is already becoming increasingly necessary in order to avoid regional inequalities in the use of current and future healthcare technologies relying on mobile connectivity, at least in part. Over the next decade or so, as new technologies emerge, the ability to achieve fast and reliable connectivity when on the move could become very significant for a range of 'smart' health devices.

Smart utilities

1.59 Smart metering and smart grids are examples of machine to machine applications designed to produce a reduction in energy consumption and carbon emissions, lower costs for consumers, and – through aligning power generation with consumption in near real time – lead to an overall reduction in the requirement for new generating capacity.

1.60 Smart metering is the connection of utility meters to a central server in order for readings to be automatically uploaded throughout the day. Smart meters are likely to evolve to include demand management functions so that at peak times power could be reduced for short periods to appliances such as fridges and air conditioning units in order to reduce peak energy load.

1.61 The scale of the smart meter programme is very large, peaking at some 14 million meters in 2018, and with some 50 million gas and electricity meters to be fitted across the UK by the end of the decade. The benefits of smart metering include more accurate bills, lower meter reading costs and reduced consumption due to consumer awareness of energy consumption.

1.62 Arqiva and O2 each won contracts in 2013 – worth a total of £2.1 billion – to deploy networks across the UK to enable smart meters. Arqiva will use long-range radio technology, supplementing their existing mast infrastructure where necessary allowing each meter to transmit energy consumption data at frequent intervals.

1.63 Smart grids – which essentially put IT and communications solutions at the heart of generation, transmission and local distribution – will also evolve over time to provide more control at the distribution network and local levels. This will allow automated solutions to be deployed integrating supply, demand and optimal network operation. Smart grid requirements and technologies are at an early stage of development and standardisation, however, it seems clear that networks which exercise control over critical national infrastructure will need to be secure and highly reliable. For this reason, smart grid connectivity is likely to require low latency (at times) and certainty of communications.

1.64 Delivering smart grids will require much of the local power distribution networks to be connected either for sensor readings or for control purposes. The challenge that this presents should not be under-estimated, as there are around 700,000 transformers and sub stations. The remote nature of large parts of these networks increases the challenge further.

Smart water meters

Smart water meter deployment is not a national policy commitment, but could offer a number of potential benefits, including efficiency. Thames Water contracted Arqiva in 2015 to deploy smart water meters, which will connect by wireless, to 3.3 million properties. This is the first UK deployment of smart water meters. The programme of installation is expected to complete by 2030, with 441,000 smart meters expected to be installed by 2020, though some 60,000 are already installed in London. As water becomes an increasingly scarce resource, smart water metering looks set to play a central role in aiding the water industry to better manage consumption and leakage.



Supply chain and logistics

1.65 The UK haulage and logistics industry employs over 2 million people in 190,000 companies, with some 80 per cent of UK freight moved by road There are nearly half a million commercial vehicles over 3.5 tonnes (HGV) on the roads and some 3.3 million commercial vehicles under 3.5 tonnes.

1.66 Competitive pressures and environmental factors are pushing fleet operators to improve efficiency and reduce costs and carbon emissions. Fleet and logistics management systems require a permanent connection to vehicles and drivers to provide real time location and average speed data, which support journey prediction and optimal routing. As a result, reliable wide area coverage on road networks has a number of potential benefits. Additionally, the benefits described above relating to connected and autonomous vehicles also apply to the supply chain and logistics sector where the emergence of vehicle platooning, for example, could result in significant efficiencies, reduced congestion and improved reliability.



PART 2: DIGITAL INFRASTRUCTURE AT THE HEART OF GOVERNMENT



Government as a digital champion

2.1 Connectivity is becoming ever more important across all sectors, not just changing how we live our lives as individuals but also transforming businesses in all parts of the economy. Securing the mobile networks necessary to put the UK at the forefront of this emerging technology will be critical to the UK's economy and to ensuring that British businesses benefit from the major opportunities presented by the growing internet application and services sector.

2.2 Infrastructure is no exception to this ongoing trend. Connectivity and the access to real time information and analytics that it allows can allow the UK to make much better use of existing infrastructure. The National Infrastructure Commission's 'Smart Power' report showed how real time information can improve the utilisation of the power system. Enhanced connectivity can also improve how we use and maintain roads, rail, water and energy networks. Importantly, in comparison to the costs of building and upgrading infrastructure such as power stations, roads and railways, the costs of integrating digital infrastructure are small. This is particularly true when installed at the outset, given that the majority of the costs of deployment relate to the laying of ducts, power supplies and the construction of masts and poles rather than the fibre, radio antennae and supporting technology.

2.3 Given the importance of the UK's digital infrastructure it is notable that there is no single government department with responsibility for it. Instead, digital infrastructure forms just one element within the many infrastructure projects and upgrade programmes that numerous government departments and agencies deliver. For example, the Home Office's procurement and delivery of the Emergency Services Network is a significant telecoms project and many of the projects for which the Department for Transport, has responsibility, such as roads and railways investment and upgrades have a significant digital component. These activities do not have national mobile connectivity as a core objective. This risks a lack of coherence in achieving the digital infrastructure the UK requires and the deprioritisation of digital connectivity as an objective.

2.4 Given the increasing importance of connectivity across all parts of the economy, digital infrastructure should sit at the core of the government's industrial strategy, ensuring that the UK can take full advantage of technologies such as artificial intelligence and augmented reality to improve productivity and develop the businesses of the future.

2.5 To grasp the inherent opportunities that digital infrastructure offers, there must be a single part of government, with senior ministerial and official leadership, supported by a well-equipped and powerful unit, that is responsible for setting the UK's overarching plan for digital infrastructure and ensuring that it is delivered in a coordinated way. The creation of a Director General lead in the Department for Culture, Media and Sport (DCMS) is a good first step.

Recommendation 1: Digital infrastructure lies at the heart of the UK's industrial strategy and affects every sector of the economy. To reflect its importance, ultimate government responsibility for digital infrastructure should reside in one place under a single cabinet minister with the authority to shape policy and delivery across government ensuring that it delivers the government's overarching digital strategy. This work should report to the Economy and Industrial Strategy Cabinet Committee. It should:

- Identify the public projects that contain a significant element of digital infrastructure and establish and maintain a plan which sets out how they can help deliver the government's overarching digital strategy and maximise the benefit of better mobile telecommunications for UK citizens and businesses.
- Hold the various parts of government that are delivering digital infrastructure to account, in order to ensure adequate telecoms network provision in the delivery of its infrastructure programmes.
- Ensure that when upgrading existing or delivering new infrastructure, such as that alongside our roads and railways, the long term capacity needs of telecoms networks are considered and met. This could include installing more fibre and additional infrastructure to make sure that networks are future-proof. It will also mean ensuring that the networks are readily accessible to communications providers.
- Be a centre of telecoms expertise within government that supports departments in determining their needs and procuring telecoms infrastructure, and support departments in demonstrating and testing of new, digitally-enabled ways of delivering public services such as education and healthcare.
- Support and challenge local government in their plans to enable the delivery of digital infrastructure; both in terms of ensuring that these plans help the UK to meet its national objectives, and that local authorities develop consistent approaches to support the deployment of mobile infrastructure across the country.



Connectivity on our major roads

2.6 The provision of consistent, good quality mobile coverage on the UK's strategic and local road networks is challenging for a number of reasons. Transmitting and receiving data to and from vehicles is may be difficult because sections of road network are located in cuttings and tunnels; because access to the road for masts can be hard to obtain, and because mobile reception within vehicles may be poor.

2.7 The UK's roads – and particularly its motorway network – frequently contain very high concentrations of mobile service users, yet the road network is diffuse, passing through extensive areas with low population density which have poor existing cellular coverage as a result.

2.8 These issues are heightened by the fact that the Mobile Network Operators (MNOs) have limited incentives to provide widespread coverage of the road network. In part this is because costs for additional network infrastructure may not outweigh additional revenues from existing or new subscribers (although this may change as new uses for roadside connectivity develop). It is also due to the fact that current coverage obligations imposed on MNOs through spectrum licences have focused on achieving coverage to premises and have not incorporated transport links.[41]

2.9 Ofcom estimates that, in 2015, 17% of A and B roads were not covered by any operator's 2G voice and text services (complete not-spots). And that 42% lacked coverage from all operators (partial-not spots). Even on the motorway network, where coverage is generally better, there remain partial and complete not spots for both mobile voice and data.

2.10 Patterns of poor coverage result in passengers often being unable to make calls and/or connect to online services. Looking to the future we expect this situation to become compounded as demand from passengers and, in particular, connected and autonomous vehicles grows rapidly, requiring roadside mobile networks to supply greater capacity. It is notable that, even if all coverage gaps were addressed on the road network, it is notable that it is doubtful capacity offered by existing networks will be sufficient. Across the next decade and beyond, as we have seen, it is expected that many of the applications envisioned for connected roads and vehicles will require or benefit from a step change in the quality of connectivity. The existing extent and quality of coverage therefore risks slowing or even preventing the deployment of future connected and autonomous vehicles technologies, which will be reliant on reliable, good quality connectivity.

2.11 As 4G networks continue to be rolled out and MNOs look to meet their licence obligations by the end of 2017, overall geographic coverage for mobile is expected to increase. However, concern has recently been expressed about the extent to which MNO efforts to meet licence conditions will lead to meaningful and future ready coverage: "The most recent figures, provided by Ofcom in its annual Connected Nations report, suggest that the MNOs have a long way to go before outdoor voice coverage reaches 90% in geographic areas. On average, the four MNOs each provided 2G and 3G coverage to 73.75% of the geographic area in the UK in 2015."[42] Given the geographic spread of the road network, this suggests that coverage gaps are likely to persist for some time unless further action is taken.

Roads, vehicles and technology

2.12 In recent years, the installation of smart motorways has become a significant programme of work for Highways England, delivering a number of benefits by increasing capacity through hard shoulder running, and improving congestion and reliability through active real time management of speeds and lane use. The smart motorway programme is set to continue improving the links between our largest urban areas: "By the end of the second Road Period, there will be continuous Smart Motorway corridors linking London, Leeds, Manchester and Birmingham".[43]

2.13 However, although smart motorways provide a number of benefits, in many respects they represent a nascent stage in the development of increasingly sophisticated road networks, where the rapid transmission of data to and from vehicles together with advances in automated in-vehicle systems will bring about further benefits.

2.14 The mass introduction and adoption of ever more sophisticated CAVs is predicted to generate benefits worth some £51 billion per year by 2030,[44] which are expected to be derived through improved efficiency, mobility,

productivity, and environmental performance. In terms of safety, it is estimated that some 2,500 lives will be saved on UK roads and 25,000 serious accidents prevented by connected car technology across the next 15 years.

2.15 The take up of CAVs will also allow for a better understanding of network conditions, such as traffic flow and speed, route optimisation and maintenance. For example, a connected vehicle could potentially use on-board technology to examine road surfaces and identify maintenance needs, using connectivity to alert the road infrastructure operator about issues in real time.

It is estimated that some **2,500 lives will be saved** *on UK roads and* **25,000 serious accidents prevented** *by connected car technology across the next 15 years.*

What are connected and autonomous vehicles?

Whilst closely linked, there are a number of distinctions between 'connected' and 'autonomous' vehicles:

Connected vehicles: are those that can communicate with other vehicles or infrastructure on the road network. A good example are freight platoons, where a lead vehicle, within which the driver has full control, is electronically coupled to other vehicles in the platoon allowing drivers of the following vehicles to cede elements of control to the lead vehicle. The connected vehicle concept is about supplying useful information to a driver or a vehicle to help the driver make safer or more informed decisions.

Autonomous vehicles: a fully autonomous vehicle is one that does not require a human to drive, instead it uses a range of systems (sensors, computer processing, etc) to safely navigate the road. This is the end point, not anticipated to be reached until the 2030s. But some vehicles are already being deployed with autonomous functionality, such as self-parking or auto-collision avoidance features.

2.16 Given such predictions, it is welcome that the government has made clear its recognition of the enormous potential for CAVs, as well as the potential for the UK to become a world leader in their development, production and deployment. Ensuring the UK keeps pace with our competitors and partners in Europe, such as Germany – where the government has recently committed to using spectrum licences to enable for provision of 50Mbps by the roadside in the next few years – will be essential.

2.17 Realising the full range of these benefits will rely on continued operational trials and research and development into both vehicle and supporting technologies, as well as work to build public support.[45] Critically, it will also require the timely provision of pervasive mobile connectivity across our road network, as well as high quality (high capacity, speed and reliability) connectivity on the busiest stretches of the network.[46] Given this context, it is unsurprising that technology will form a very significant theme in preparations for the second Roads Investment Period, between 2020 and 2025.

How will CAVs Function?

In-car features such as radar, sensors, and processing will provide for a number of CAV functions, such as lane monitoring and collision avoidance. However, there is also a requirement for significantly increased connectivity on road networks, both between vehicles and between vehicles and infrastructure, in order to secure CAV benefits fully and rapidly.

V2V and V2I

The connected vehicle market primarily consists of two broad types of connectivity providing technology: Vehicle-to-Vehicle (V2V) communications, which takes place directly between vehicles, and; Vehicle-to-Infrastructure (V2I) which takes place between vehicles and a fixed piece of the surrounding infrastructure, such as a roadside small cell. Both technologies generally currently rely on Dedicated Short Range Communications (DSRC) to transmit and receive information.

V2V technologies – many of which are concerned with collision avoidance – require that other vehicles on the road are also connected, otherwise non-communicating vehicles are only visible to connected vehicles through separate features, such radar.

V2I applications tend to be less immediate or safety-critical so have a broader scope. For example, V2I is seen to increase possibilities for more complex data analysis, as well as a more general information feed for entertainment purposes. It can also provide redundancy should on-board systems fail. Unlike V2V, V2I only requires the infrastructure and the vehicle to be connected, allowing for useful applications immediately (once supporting infrastructure is in place) without the need for very significant market penetration. As a result, certain V2I applications may be market ready before those for V2V, which will make V2I a significant force in leading market adoption of connected vehicles.

Where will CAVs operate?

The ultimate end point for CAVs will be the ability to function across the full variety of environments – from congested streets, to residential areas and busy highways – which each offer a range of potential benefits. For example, increased connectivity in cities could allow for smart signal phasing of traffic lights, and real time information being relayed to vehicles about parking space locations. There are also safety gains, such as at busy intersections where connectivity could allow for real time data to be shared about the locations/intentions of vehicles.

On our busiest strategic roads where large traffic volumes travel, often at high speed and in dense formation, similar benefits exist, as well as those opened up through the platooning of vehicles and warnings about congestion and incidents ahead.

The nature of mobile coverage will be an important determinant of where and when CAVs can operate, and with what sorts of features. Roads in suburban areas may, in general, have relatively low data capacity requirements, at least in the near term, due to lower traffic volumes and densities. As a result, cellular coverage may provide sufficient connectivity in such areas for CAVs in the near term. However, in busy areas, where capacity requirements are greater, dedicated coverage (through for e.g. small cell deployments) is likely to be necessary to allow for increased data capacity needs. And, where the reliability and quality of connectivity is important or critical in nature, dedicated networks will be necessary.

Roads – digital infrastructure considerations:

2.18 The speed and nature of CAV uptake will be significantly affected by the telecommunications infrastructure available to provide connectivity to vehicles. As set out above, existing mobile coverage across our road networks can be unreliable, causing difficulties for road users, and also for vehicle manufacturers seeking to enable increasing levels of reliable connectivity in new models. Widespread road coverage should therefore be a matter of priority in the near term.

2.19 On the busiest roads and in busy urban areas mobile capacity will need to grow significantly to meet forecast service quality needs. Similarly on the strategic road network, concentrated numbers of vehicles with sophisticated connectivity needs will result in requirements that existing mobile networks are unlikely to be able to meet. Meeting the demand for higher capacity is likely to require a denser network of much smaller cells, along with improved technology.

2.20 Analysis conducted for the NIC suggests that in dense urban areas where there are likely to be sufficient incentives for the deployment of small cells at scale, to deliver improved coverage and capacity, which should in turn help meet the connectivity needs of CAVs in urban areas. However, on major roads, where improved connectivity can help to realise a range of

A 5G ready roadside network

Future deployments of telecoms networks at the roadside on the Strategic Road Network (SRN) would benefit from being able to take advantage of extensive existing infrastructure. A UK wide network of ducts, poles and in some places high speed and high capacity optical fibre network is in place on all of the UK's motorways and major trunk roads. Fibre and ducting is used for operational purposes, providing connectivity for equipment such as CCTV cameras, information signage and message boards to gantries. Analysis for the NIC has found that there is potentially capacity on the fibre and ducting network that could be used to provide better wireless coverage and to deliver high speed connectivity to vehicles enabling numerous transport related applications.

The analysis found that connecting approximately eighteen thousand wireless sites utilising the existing infrastructure as far as possible along England's motorways would cost approximately £380 million and deliver the necessary underpinning platform for 4G and 5G high capacity connectivity as well as enabling V2V and V2I communications for CAVs.

Liaison with the telecoms sector suggests that there are a number of opportunities for such a network to be funded commercially, for example with the infrastructure provider – potentially a neutral host – able to monetise 'connectivity as a service' through provision of data and connectivity to highways authorities, car manufacturers and to MNOs. Service obligations for future 5G spectrum releases could potentially be employed to commit spectrum holders to delivering roadside services and to provide investment certainty.

benefits, problems with accessibility (for example, for safety reasons). and the more limited incentives on MNOs, mean it is much less certain that current arrangements will deliver the connectivity required. To ensure sufficient connectivity is provided, rather than maintain the status quo and suffer the deployment lag which this would entail, better coordination, investment and efficient utilisation of the significant existing roadside telecoms assets will be necessary.

2.21 The provision of a robust and forward looking communications network infrastructure on our motorways should inform the process for ensuring that there is adequate coverage and capacity on the rest of the road network to meet future needs, including the partnerships needed between road stakeholders and mobile communications providers.

Recommendation 2: Our motorways must have mobile telecommunication networks fit for the future. It is vital that our motorways are able to meet both the long term operational needs of connected vehicles and the connectivity needs of the passengers. This will necessitate the timely installation of an open and accessible mobile telecommunication and backhaul network that is fit for the future.

The government should set out its plans for how to deliver this by the end of 2017. As part of this work consideration should be given to who is best placed to install, manage, fund and own the network, noting the potential for private sector funding.

Ensuring that best use is made of the existing infrastructure, such as masts, poles, ducts power supplies and the fibre network alongside our motorways, so that it can be used to support the backhaul of mobile data will be essential.

Ultimately, the government should ensure that the necessary infrastructure is in place on motorways by 2025 at the latest if it wants to offer a reasonable level of connectivity on a timescale consistent with the deployment of 5G networks.

Ofcom should set out how a regulatory regime would support these different operating models.



Connectivity on our main rail routes

2.22 Mobile coverage on UK railways is reliant on existing MNO cellular networks, which generally utilise base stations located some distance away from railway lines.[47] This has resulted in poor mobile coverage and capacity on rail routes to date. The challenges include:

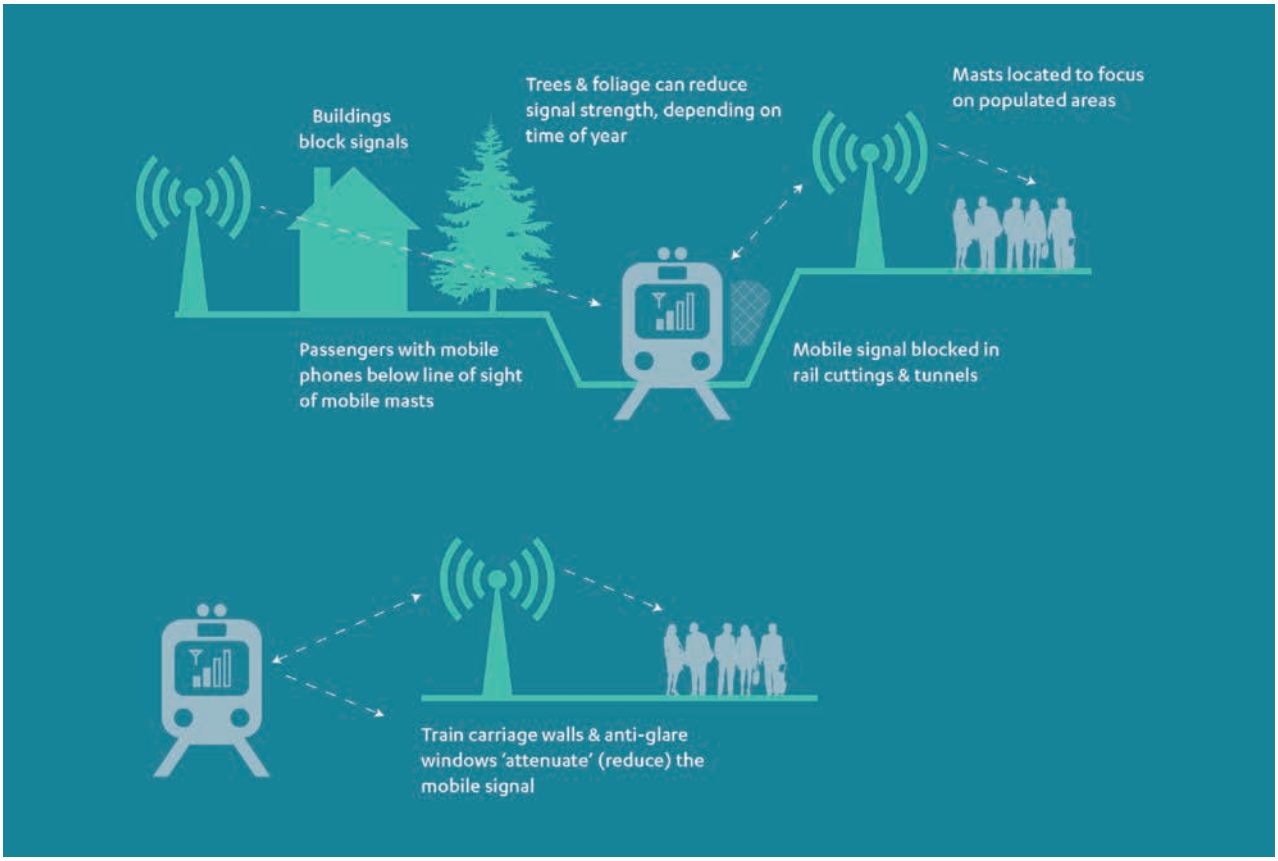
- Around 40 per cent of railways are in tunnels or cuttings, causing base station signals to be blocked. These difficult geographies mean that even with near-ubiquitous geographic coverage MNOs would be unlikely to provide sufficient coverage and capacity to deliver a quality service to passengers without trackside infrastructure;
- Train carriages and windows can strongly attenuate wireless signals, impeding reception further;
- Large numbers of people concentrated in small areas on carriages, often moving at high speeds, and in close proximity to other trains;
- The mobile market provides few incentives for MNOs to invest in improving rail coverage;[48]
- Coordination issues can occur due to the number of stakeholders involved, which can be exacerbated by poorly aligned incentives to roll out mobile networks along the railways.[49]

2.23 As a result of these challenges, passengers are often unable to make or receive phone calls reliably and frequently receive poor data connectivity, reducing satisfaction and productivity. Lack of sufficient rail corridor connectivity also risks impeding the realisation of a number of Digital Railways initiatives because features such as digital in cab signalling, operational improvements as well as real time information for passengers rely on good, reliable trackside coverage.

Project SWIFT

Project SWIFT (Superfast Wi-Fi In-carriage-for Future Travel) is an example of a UK railways Wi-Fi trial between Glasgow and Edinburgh. It is being undertaken by CISCO together with partners including Innovate UK and Network Rail. SWIFT aims to deliver high quality and high speed Wi-Fi broadband to rail carriages running between Glasgow and Edinburgh. It is an 18 month project that will demonstrate high speed connectivity (handover durations of 2ms) that improves passenger experience, enhances commercial opportunities and improves train management through increased operational data. SWIFT will utilise the existing high quality trackside fibre that is in place between Edinburgh and Glasgow and put in place a dedicated track to train infrastructure of small cell devices mounted on masts and connected to the fibre, using unlicensed spectrum.

Figure 6: The challenges of providing train connectivity



2.24 In response to these long standing issues, the Department for Transport announced an 'On-Train Wi-Fi' policy last year, which made clear the government's commitment to improving mobile connectivity for rail passengers.[50] This programme is timely and welcome; passenger demand for on-train broadband services is evident[51], and the benefits of improved trackside connectivity could be very large, for both passengers and rail operations.

2.25 The programme is now under way and will utilise the rolling franchise competition process to make Train Operating Companies (TOCs) responsible for delivering in-train Wi-Fi, which must meet a set of minimum service levels prescribed by the DfT. TOCs will be free to negotiate their own solutions with service providers in order to meet the service level metrics, likely resulting in a variety of approaches.

2.26 An encouraging start has been made; several proof of concept trials have begun in conjunction with Network Rail Telecom, such as project SWIFT in Scotland and the Chiltern Railways/EE deal for Continuous On-Train Wi-Fi Services. The aim of these trials is to allow telecoms service providers to showcase potential solutions, and gain insights into the best ways forward.

2.27 There are broadly two approaches open to TOCs. The first is to work chiefly with MNOs to use their networks to backhaul mobile data from the trains using commercially available spectrum and current 4G technologies with "in fill" coverage (at, or close to, trackside) added where required to overcome connectivity issues, for example in tunnels. This is the approach adopted by EE/Chiltern Railways. The alternative approach is to focus on delivery of dedicated trackside infrastructure, installed along the railways and using either licensed or unlicensed spectrum. This is the approach adopted in the SWIFT trial.

2.28 Over the course of the franchise renewal process (which will run until 2028) it is anticipated that TOCs will negotiate commercial agreements with one or more telecommunication providers to deliver the minimum service level through a range of technological solutions.

2.29 It is important to note that the role of Network Rail Telecom will be central in ensuring the success of solutions chosen by TOCs. Track-side telecommunication assets and infrastructure are located in a hazardous and safety-critical environment. The experience and competence of Network Rail Telecom will, therefore, be essential in any solutions that seek to leverage Network Rail assets.

2.30 Though focus here has been on rail, a similar set of benefits could be realised through improved mobile connectivity on underground/light rail networks. The NIC note that Transport for London (TfL) are working on a plan to consolidate their telecommunications networks including those they run and those they buy in. This is the right approach, and TfL should look to produce their plan as quickly as possible.

Railways – considerations

2.31 Poor mobile coverage on our railways has been a perennial issue, but the provision of good quality connectivity to rail passengers could bring about a range of benefits, indeed, earlier this this year, it was described by the Transport Select Committee as an, "important, and potentially transformative, factor".[52] It is therefore welcome that the government is actively seeking to address longstanding mobile coverage and capacity issues on UK railways.

2.32 Looking to the future, and the capacity demands expected in the 5G era, it will be important to make timely decisions about the nature of the networks to be deployed in order to meet longer term passenger and operational needs. Central to these considerations will be the degree of coverage and capacity considered necessary.

2.33 At present, the minimum service level set by the DfT for on-train Wi-Fi aims to deliver a data speed per passenger equivalent to 100 Mbps backhaul per train for 95 per cent of the route (for 85% of passengers journeys). This level of connectivity is aimed at supporting basic internet services, such as email access, and Wi-Fi voice calls. Analysis produced for the NIC suggests that, whilst delivering a 100Mbps per train is a target that could potentially be met relatively quickly (by using a combination of MNO cellular networks with 'in-fill' where required) it is modest based even on today's user requirements.

2.34 Backhaul of 100Mbps per train equates to an approximate data speed target of 256kbps per passenger. However, these assumptions are not based on fully loaded trains – which may carry in the order of 800 people – and assume only 1 in 4 connected passengers for that figure to be possible. This could lead to passengers in some circumstances, for example on peak loaded trains, experiencing a poor service in the near term. Looking over a 10 – 15 year horizon, this basic connectivity level is unlikely to meet future demand.

2.35 There are requirements on TOCs to accommodate growth of 25 per cent per annum in demand, but this is less than half of the currently observed rate of mobile data growth.[53] Ofcom reported eightfold mobile data growth between 2011 and 2015, substantially exceeding their previous forecasts.[54] The growth assumptions underpinning the current approach may therefore significantly underestimate demand across the next decade and beyond.

2.36 Published analysis of 5G requirements suggests significantly greater demand, as do industry expectations. A widely accepted target for 5G connectivity is 50Mbps per user on an average basis[55], though with much greater peak demand. This suggests that a more realistic, future proof approach would be to target backhaul of tens of gigabits per train, and that this degree of connectivity would in particular be necessary on the busiest mainline and commuter routes.

2.37 Targeting this level of demand necessitates extensive deployment of trackside infrastructure along rail routes. This is likely to be the most viable way to achieve high data rates and enable low latency connections. It also has the potential significant advantage of making use of the existing trackside infrastructure such as ducts and poles, following the SWIFT model. It will also be vital to ensure that the mobile connectivity needs of new railway lines are given full consideration at the earliest stages so that appropriate trackside mobile infrastructure can be deployed efficiently as new railways are constructed.

2.38 Work commissioned by the NIC has estimated costs for such an approach to be in the order of £500-£600 million for the UK's main rail routes. Commercial approaches to funding these infrastructure costs appear likely to be feasible due to opportunities for infrastructure providers to secure revenue streams from improved trackside connectivity.

Recommendation 3: Rail passengers should have high capacity wireless connectivity. This should be achieved through a delivery model that utilises trackside infrastructure to provide an open and accessible mobile telecommunication and backhaul network that is fit for the future.

The government should set out its plans for how to deliver this by the end of 2017. As part of this work consideration should be given to who is best placed to install, manage, fund and own the network, noting the potential for private sector funding.

Ensuring that best use is made of the existing infrastructure, such as masts, poles, ducts power supplies and the fibre network alongside our railways so that it can be used to support the backhaul of mobile data will be essential.

Ultimately, the government should ensure that the necessary infrastructure is in place on the main rail and key commuter routes by 2025 at the latest if it wants to offer a reasonable level of connectivity on a timescale consistent with the deployment of 5G networks.

Ofcom should set out how a regulatory regime would support these different operating models.

Engaging local government as a partner

2.39 The deployment of small cell radio antennae using existing 4G technologies is already being seen in some of the busiest urban areas simply to address existing capacity challenges created by ever increasing mobile data requirements. In order to enable the enhanced mobile services envisaged from 5G, however, a step change in the number and density of such small cell networks is anticipated. This will require the deployment of tens of thousands of small cells in our towns and cities.

2.40 The provision of so many new cells will be a significant challenge in terms of finding suitable sites and providing supporting infrastructure such as backhaul, as well as ensuring that telecoms networks meet local needs.

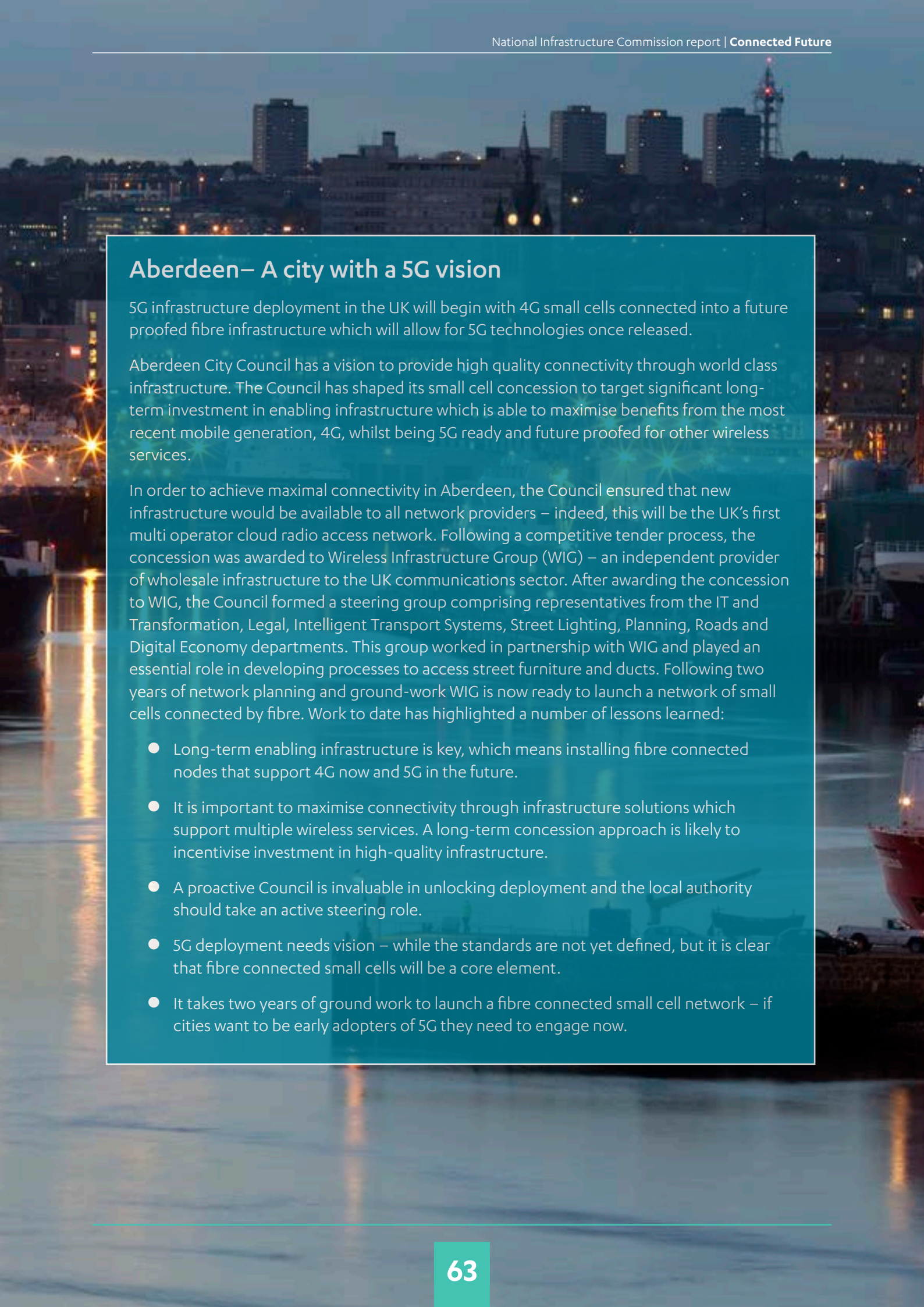
Why are dense networks necessary in urban areas?

2.41 Mobile infrastructure in dense, urban areas is typically deployed by MNOs on the rooftops of office blocks and residential buildings or on poles in the street. These sites provide the key capacity layer for mobile broadband in our towns and cities, which today delivers mobile broadband speeds averaging 15 Mbps. However, there is growing expectation and demand for this mobile connectivity to grow further. 5G millimetre wave small cells offer the ability to provide ultra-fast speeds (more than 100 Mbps) and high levels of capacity while on the move.

2.42 The benefits of providing this level of connectivity could be very significant and wide ranging, enabling the anticipated proliferation of data rich services, such as mobile augmented reality, to become mainstream in densely populated areas. It will also be needed to support the smart city of the future, which will benefit from a fast, responsive, and stable mobile network, able to handle a vast amount of data.

2.43 5G and millimetre wave Wi-Fi small cells may cover an area just 100m – 200m in radius. This implies significantly more cell sites than are currently available could be needed to deliver the ultra-fast broadband speeds and high levels of capacity that future applications could require.

Analysis for the NIC found that as many as **42,000 small cell sites** *could be needed to deliver the* **ultra-fast broadband speeds expected of future networks** *in an area the size of the City of London.*



Aberdeen– A city with a 5G vision

5G infrastructure deployment in the UK will begin with 4G small cells connected into a future proofed fibre infrastructure which will allow for 5G technologies once released.

Aberdeen City Council has a vision to provide high quality connectivity through world class infrastructure. The Council has shaped its small cell concession to target significant long-term investment in enabling infrastructure which is able to maximise benefits from the most recent mobile generation, 4G, whilst being 5G ready and future proofed for other wireless services.

In order to achieve maximal connectivity in Aberdeen, the Council ensured that new infrastructure would be available to all network providers – indeed, this will be the UK's first multi operator cloud radio access network. Following a competitive tender process, the concession was awarded to Wireless Infrastructure Group (WIG) – an independent provider of wholesale infrastructure to the UK communications sector. After awarding the concession to WIG, the Council formed a steering group comprising representatives from the IT and Transformation, Legal, Intelligent Transport Systems, Street Lighting, Planning, Roads and Digital Economy departments. This group worked in partnership with WIG and played an essential role in developing processes to access street furniture and ducts. Following two years of network planning and ground-work WIG is now ready to launch a network of small cells connected by fibre. Work to date has highlighted a number of lessons learned:

- Long-term enabling infrastructure is key, which means installing fibre connected nodes that support 4G now and 5G in the future.
- It is important to maximise connectivity through infrastructure solutions which support multiple wireless services. A long-term concession approach is likely to incentivise investment in high-quality infrastructure.
- A proactive Council is invaluable in unlocking deployment and the local authority should take an active steering role.
- 5G deployment needs vision – while the standards are not yet defined, but it is clear that fibre connected small cells will be a core element.
- It takes two years of ground work to launch a fibre connected small cell network – if cities want to be early adopters of 5G they need to engage now.

Delivering densification

2.44 A number of challenges will need to be addressed in order to achieve this level of provision. Key amongst these are the enabling fibre necessary to backhaul high capacity data from the base stations to the network core. Fixed telecommunications operators will need to play a central role if dense networks of small cells are to be able to be deployed. BT, Virgin Media and Vodafone already carry significant proportions of data traffic on their fixed fibre networks in the UK. Ofcom's proposals around duct and poles access are likely to be important to enabling the necessary fibre to be provided for small cell deployments.

2.45 Plans recently announced by government to improve access are also a positive step forward in encouraging more fibre provision, as is the funding for fibre deployment announced in the 2016 Autumn Statement. Suitable arrangements amongst operators in terms of fibre and duct access flexibility, maintenance, sharing of contractual obligations and future deployment will also be necessary. In the coming years, a new challenge will be the extension of fibre and connecting cells into non-typical locations, such as street furniture, so that operators can roll out new sites in a cost effective and timely manner.

2.46 Operators will have to be prepared for large scale deployments, and there are signs that they are gearing up. BT, for example has started testing new software and virtualised network technologies in readiness for connecting the numerous wireless sites required to deliver future networks. These will likely become commercially available around 2019 coinciding with the completion of 5G standards and live trials.

2.47 A notable feature of small cell densification will be the need for access to street furniture. This will require collaboration between network operators and landlords (generally local authorities) to handle agreements and issues that might occur due to deploying telecommunications equipment on infrastructure not designed for that purpose. There is currently no common approach to this type of collaboration, though pioneering Smart cities projects such as Bristol is Open and collaborations between forward thinking authorities such as Aberdeen Council and network providers will offer valuable insight into how best to drive network provision (see break out box).

2.48 Early signs from across the UK are that the process tends to be fragmented across different local authorities and negotiations are often legally complex and protracted, making MNOs reluctant so far to get deeply involved. Aspects such as planning policy, legislation for code powers, and guidelines for deployment at street level will need to be addressed before dense site deployment can take place.

2.49 Taken together, these challenges suggest it would be unwise to assume that small radio cells will necessarily be cheaper or quicker to deploy than other types of cell architecture. Significant backhaul requirements together with the sheer volume of sites required will result in the need for significant investment. And urban restrictions such as local authority permits and traffic management needs could prove to be costly obstacles, causing delays and expense.

2.50 Therefore, to make timely 5G deployment possible, and ensure networks can expand to meet future requirements in dense urban areas, active local government engagement and support will be necessary. This should include the development of robust and coordinated plans for the deployment of enhanced mobile networks, drawn up by local authorities in collaboration with the broader Local Enterprise Partnership and incorporating input from network providers. Some Local Authorities and Local Enterprise Partnerships are already starting to develop their thinking in this area and developing policies such as the City of London's Digital Infrastructure Toolkit and the North East LEP's plans for a digital test bed.

2.51 In this context, there is also a role for central government, which should keep under review recent legislative changes impacting the sector: planned changes to the Electronic Communications Code, currently passing through Parliament, as well as amendments to planning regulations appear to be steps in the right direction, which should help encourage both small and macro cell deployments.[16] Government must now monitor how these efforts to stimulate network investment end up working in practice and keep open the possibility of further legislative changes if necessary.

2.52 Whilst it is likely that the precise model of small cell deployment will vary to some extent across local areas, there will be benefits from harmonising the general approach taken, which should increase efficiency and incentivise investment. Ensuring that the optimal approach is identified and implemented should be a priority. Central Government should therefore prioritise the piloting of a range of delivery models across diverse environments.

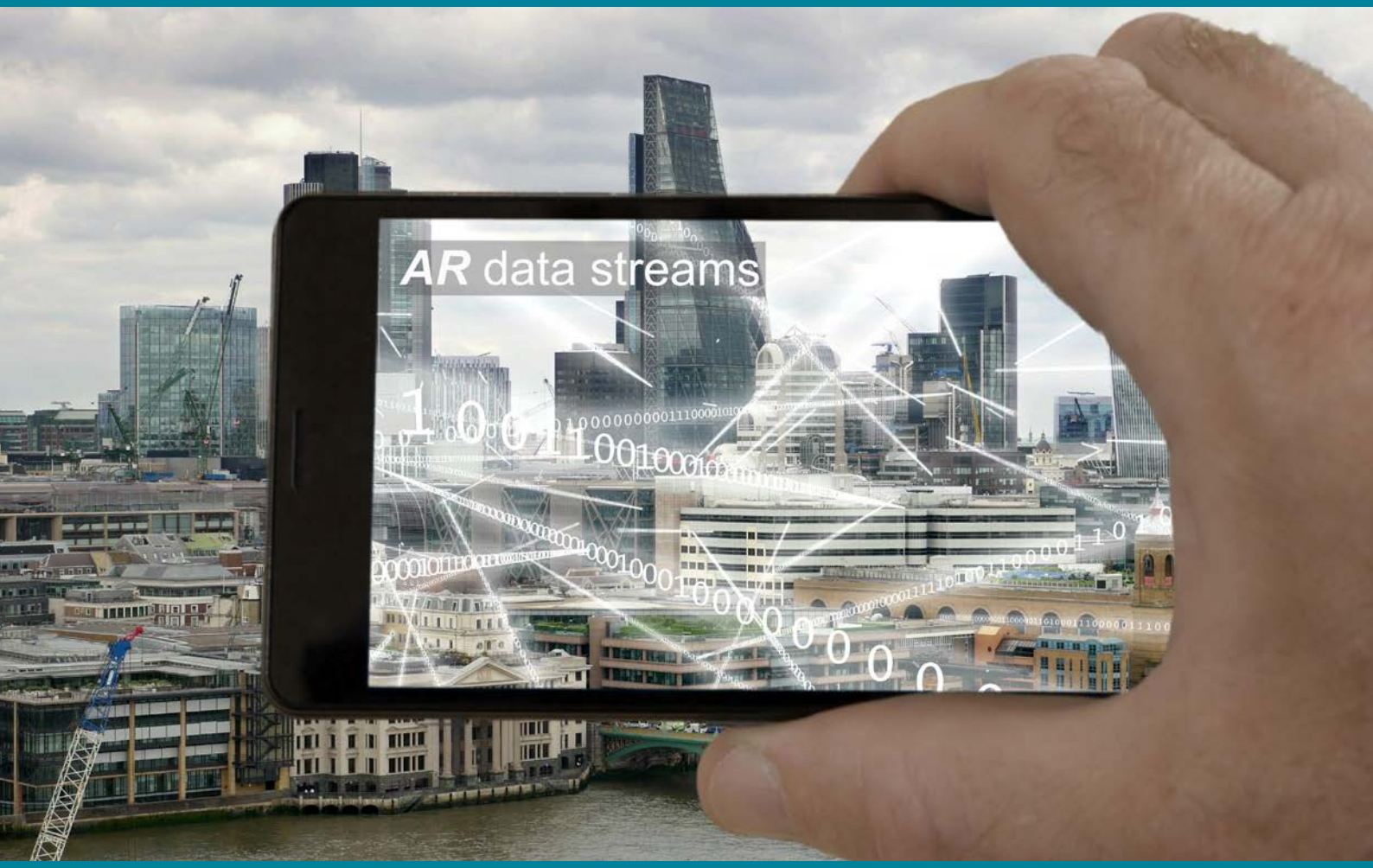
Recommendation 4: Local government should actively facilitate the deployment of mobile telecoms infrastructure:

a) Local authorities should work together and with Local Enterprise Partnerships (LEPs) to develop coordinated local mobile connectivity delivery plans. These plans should:

- set out how local authorities and LEPs will enable the deployment of mobile networks and maximise the opportunities and benefits to residents and businesses;
- be developed in discussion with mobile network operators and infrastructure owners;
- identify a designated individual with lead responsibility for engaging with mobile telecoms infrastructure providers;
- consider the role of local government assets and infrastructure, (e.g. land, buildings, roads, street furniture) and help coordinate the role that other public buildings in an area (e.g. hospitals and universities) can play to facilitate the deployment of mobile telecoms infrastructure; and
- consider how the deployment of digital infrastructure can be established as a priority in local planning policy.

Local authorities and LEPs should report annually to the government department with responsibility for digital infrastructure on their progress delivering against these plans.

b) Local models for facilitating the deployment of these networks should be piloted and evaluated to inform national roll-out. Any pilot programme should allow for the evaluation of deployment models in different types of area (e.g. urban, rural, coastal) and in both single-tier and two-tier local government areas. It should also seek to establish how high quality design can minimise the impact of hosted infrastructure on the built environment. Such pilots would be a good use of a proportion of the funding recently announced in the Autumn Statement to support mobile telecoms infrastructure.



One of the future applications unlocked by 5G is Augmented Reality (AR). AR enriches reality by providing additional information that is relevant to the surrounding environment and context of the user. A very high data rate and low latency (lag) are necessary for enabling AR. This means that, for AR applications outside the home or workplace, high speed and high capacity mobile infrastructure networks will be required.



PART 3: MEANINGFUL COVERAGE

The importance of high quality pervasive coverage

3.1 The services that are delivered over mobile wireless have moved from being a luxury to an essential. This trend is only set to continue into the next decade as our personal lives and businesses rely increasingly on cloud connectivity, and our digital economy is underpinned by it. Having limited access due to poor coverage will be increasingly problematic to people and businesses.

3.2 As a nation, the full range of benefits of mobile services can only be realised when their reach is maximised.[56] Meaningful coverage where people want it is, as was highlighted recently by the British Infrastructure Group, necessary now for mobile phone users.[57] Over the next decade, widespread and high quality mobile coverage could enable transformational change to sectors such as connected health, education, transport and the internet of things. It could also put the UK in a leading position to enable our digitised industries and the digital services sector to flourish. Failure to establish first rate coverage risks missing such opportunities as well as exacerbating the digital divide.

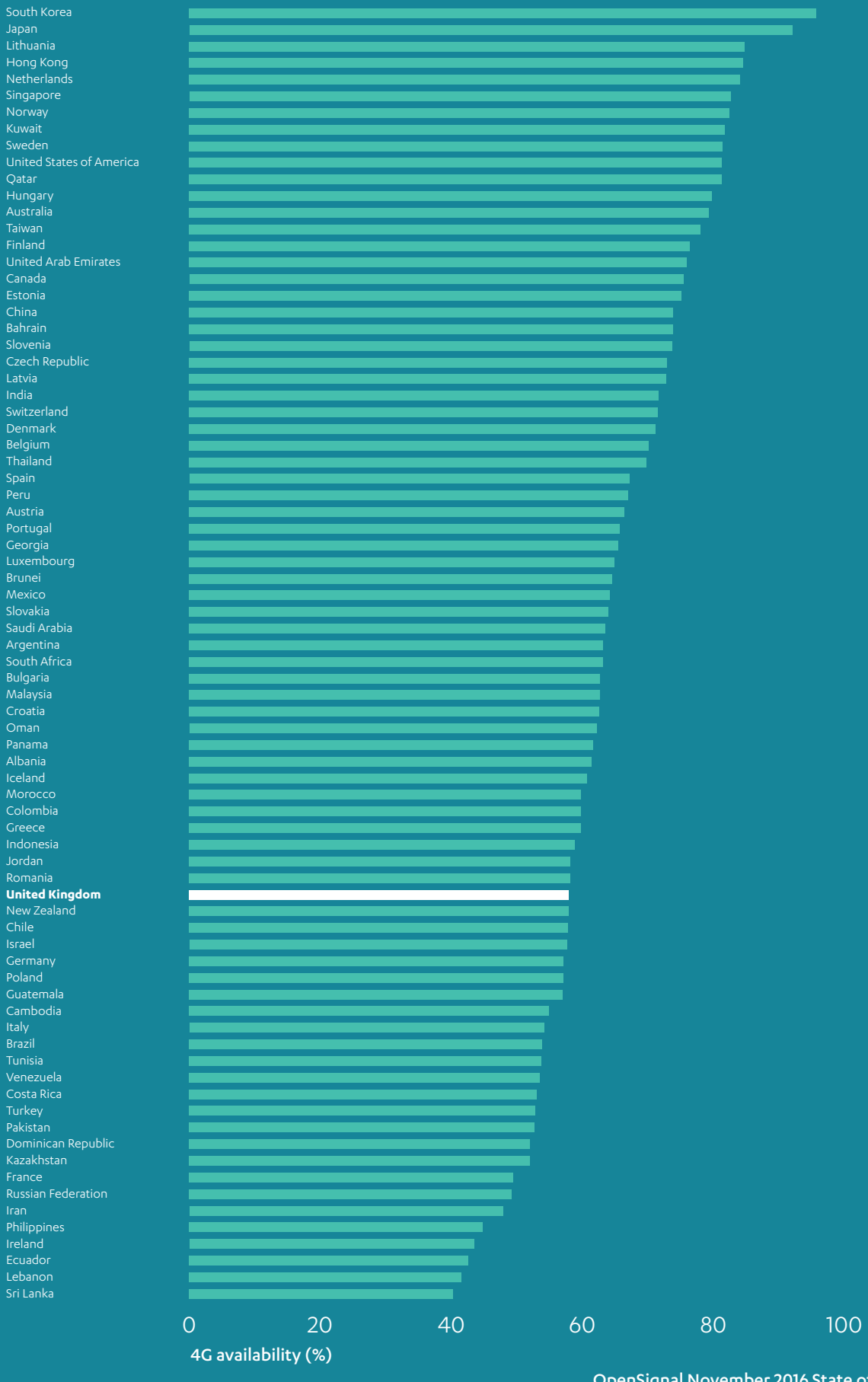
3.3 However, left purely to the market, experience shows we may expect the densest areas of population, our major towns and cities, to receive the best (and first) coverage. Less populated areas, or areas which are more difficult to reach with wireless connectivity, will need to make do with poorer quality or non-existent coverage for some time, and potentially indefinitely. This is of particular concern because in future much of the good brought by mobile networks may increasingly be societal – with citizens benefiting through improvements to health and other public services – but the incentives for network operators to deploy the pervasive networks that will be necessary are not clear.

3.4 These issues need to be addressed to enable widespread provision and adoption of various future services in the UK, with high quality mobile access where people live, work and travel. Addressing coverage issues now will provide the infrastructure platform on which successive generations of mobile technology will sit, be they 5G, 6G or next generation Wi-Fi.

How does the UK benchmark against other nations?

3.5 The UK is currently not in a leading position when it comes to the availability of mobile services. While it benchmarks well within Europe and more widely on having a highly competitive telecommunications sector – leading to benefits such as low prices relative to many countries[58] – the evidence on quality and coverage of mobile telecommunications services shows it as firmly middle of the pack.

4G AVAILABILITY



OpenSignal November 2016 State of LTE Report

3.6 OpenSignal's most recent data[59] from their 'State of LTE' November 2016 report shows the UK is behind the most forward looking technology nations such as South Korea, Japan, Singapore and the US in terms of the nationwide availability of 4G. They suggest it ranks 55th out of just under 80 countries. Within Europe the UK is in a middling position, behind countries such as Sweden, Norway, Switzerland, Spain & Greece; approximately level with Germany, and ahead of France and Ireland.

3.7 Compared to other nations, the UK has been relatively slow to deploy both 3G and 4G technologies widely. To reach the leading edge of mobile developments and to meet demand and stimulate growth in future there will need to be significant and well-targeted investment in both network equipment and infrastructure.

UK coverage

3.8 There is evidence to suggest that there is a gap between consumers' experience of the mobile services they receive and the coverage reported by operators and government. This gap prevents consumers from making informed purchase decisions based on coverage. It also creates expectations around policy interventions that may not be realised – for example expectations around the most recent obligations on 4G and geographic coverage (discussed below) may not be met in terms of real services. This gap must be closed.

3.9 The difference in the coverage reported by operators and the experience of users is in part explained by a lack of clarity around what coverage actually means. "Having coverage" is not as simple as it might sound (see breakout "Define coverage"), and depends on exactly what the user wants to do – send a text, make a call, browse the web, or watch a video. Complicating things further, a user may in theory have coverage in their current location, only for it not to be available because it is not from the provider they are subscribed to.

3.10 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.

What is 'coverage'

The quality of the connection a mobile handset receives, and therefore the services that can be enjoyed, is dependent upon a number of factors. These include the distance of the user from the base station, the exact location of the user (as buildings & trees can block signals), and also the number of other people who are actively using their handsets nearby (in the same cell).

All of these factors continuously vary; for example the number of active users sharing the capacity of a cell swells at certain peak times during the day, and diminishes at night. Therefore saying with precision what quality of connection a mobile user can expect at an exact location and time across the UK is very difficult. Communicating this in a meaningful and simple way to mobile phone customers even more-so.

For this reason mobile operators and public policy makers have historically used computer predictions of phone signals to estimate the quality of mobile coverage people will receive across the UK. This creates the risk that it fails to reflect the true user experience. Predictions may suggest a good service based on the modelled signal coverage for example, but not account for a busy location or time of day, meaning that a user can't make a call. This explains the sometimes frustrating experience of having signal – indicated by several bars on your phone – but not necessarily being able to do what you want with it.

This situation is further exacerbated by differing definitions of "coverage". Coverage may mean in one circumstance the ability for the phone to simply connect to the network, or in another the ability to make a call, or – in another – the ability to watch a video.

With the advent of smart-phones much richer data is becoming available to establish a true picture of the coverage and quality of service that is experienced. Smart phones can collate detailed statistics on service experience which can be tagged with location and time. This data can be collated from millions of smart phones, making operators and third parties increasingly able to publish richer statistics of phone performance based on actual experience. OpenSignal is one such 3rd party service.

3.11 For example, Ofcom estimates outdoor voice coverage to be greater than 98% of UK premises.[60] Coverage for high speed mobile data is now also predicted to be high – Ofcom reports the availability of 4G mobile services having increased rapidly, with the UK having 97.8% of outside premises (i.e. coverage immediately outside of homes and businesses) covered by at least one operator in May 2016.[61] Figures reported by mobile operators broadly agree with Ofcom data. For example EE reports that their network provides 4G coverage to 97% of the population in the UK.[62]

3.12 These figures contrast with those derived from crowd sourced data from smart phones. For example, OpenSignal's data in their 'State of LTE' November 2016 report suggests that in the UK EE (who performed best in their tests) gave users access to an LTE connection 64% of the time, and the operator '3' gave access figures to the 4G network 44% of the time.[63]

3.13 Although Ofcom report that outdoor voice coverage is available at more than 98% of UK premises, this is concentrated around urban centres (see the box on UK Coverage below). In rural areas, Ofcom data shows users have a starkly different experience to their city dwelling neighbours; 28% of rural premises are in voice not-spots (see the box below on not-spots).

In rural areas **just under 80% of premises** *are in a* **4G not-spot**.

3.14 This picture is exacerbated when 4G mobile broadband is considered. Ofcom's most recent reports suggest that although nearly 98% of UK premises were in areas with some outdoor 4G coverage, in urban areas of the UK around 20% of premises are in a not-spot. In rural areas just under 80% of premises are in a 4G not-spot.

Not-spots

Not-spots are areas where users may not have coverage.

Complete not-spots are areas where there is no mobile coverage. It does not matter which mobile operator you are subscribed to, there is simply no coverage from any mobile network in that area.

Partial not-spots are areas where there is coverage from at least one of the four national mobile network operators (3, EE, O2, Vodafone). However if it is not the operator you are subscribed to (whether directly from EE for example, or through a retail provider such as GiffGaff or Tesco mobile) you will not receive service. Not-spots are more prevalent outside urban centres in the UK.

3.15 Figures which better represent the daily experience of mobile phone users also need to account for coverage on roads, railways, and around towns and businesses rather than simply addressing residential premises. Here, there is further evidence of patchy coverage. Ofcom estimates, for example, that 2G not-spots account for nearly 60% of UK A & B roads. For 4G services, though the last estimate is from data in 2015 and roll-out is still underway, partial not-spots account for around 45% of A & B roads, and complete not-spots account for a further 47%.[64]

3.16 On motorways, OpenSignal UK Roads and Rail Report (2014) report that users failed to get a 3G or 4G signal 24% of the time and on A-roads 33% of the time. On rail, they report that rail passengers were without a 3G or 4G signal 28% of the time.

3.17 In summary, there is a significant gap in the reporting of coverage and the consumers' experience which is not in consumers' interests. This is because:

- Computer predictions of coverage are not representative of real service levels provided to consumers;
- Coverage is not clearly defined – it is not related to a service or package of services;

UK COVERAGE

Voice Coverage: Urban Premises



Voice Coverage: Rural Premises



Figure 7: Urban verus Rural Voice Premises Coverage

4G Coverage: Urban Premises



4G Coverage: Rural Premises



Figure 8: Urban verus Rural 4G Premises Coverage

Voice Coverage A&B Roads



4G Coverage A&B Roads



Figure 9: Voice and 4G Coverage of A & B Roads

All operators *Partial not-spot* *Complete not-spot*

- Quoting coverage to residential properties is not representative of mobile consumption – for example, it ignores roads and railways; and
- Partial not-spots remain an issue of significance. Figures quoting coverage for "at least one mobile operator providing coverage" do not help consumers since they are tied to the coverage provided by the operator to which they subscribe.

The reasons for poor coverage in the UK

3.18 It appears deployment has struggled to keep pace with the transition to a world where ubiquitous good quality connectivity is an expectation.

3.19 While competition, in principle, drives investment in aspects of networks, this has not led to universal coverage. There remain some areas where the benefits to an operator, though not necessarily the societal benefits, from investing in marginal sites appear to be less than investment costs.

3.20 Deployment costs rise quickly when providing mobile infrastructure to inaccessible areas for example on our motorways and in our rail-cuttings where restricted access and other factors such as safety drive costs up. Similarly, deployment in rural areas becomes increasingly expensive as the density of customers per base station deployed decreases and the costs of base station and backhaul infrastructure increase. This makes it more difficult for operators to make a clear profitable business case to deploy. Other factors such as regulation around site acquisition, rental & planning can also impact costs.

3.21 Enhanced coverage by an operator may drive their ability to acquire and retain customers. However as we have seen the ability of competition to drive coverage is limited in part due to the inability of consumers to understand true coverage and network quality and make informed choices. It is further limited as consumers have many other factors to consider in their buying and switching decisions – particularly in the world of quad and triple play phone/broadband/mobile/TV bundling.

3.22 It appears that there are insufficient customers in very rural areas to justify ubiquitous coverage. More surprisingly, operators do not appear to have sufficient commercial incentives to ensure good coverage even in some built up areas. Again, in these cases, private benefits (expressed in terms of customers' willingness to pay or the value they assign to ubiquitous coverage) may not reflect full social benefits from ensuring universal coverage, particularly where the costs of deployment may be driven up by factors such as planning issues, poor local coordination or inaccessibility of key sites.

3.23 The potential for societal benefits to outweigh the revenues an operator can capture has been recognised by Ofcom, leading to coverage obligations being imposed both on 3G licences and on one 4G licence. In its statement on the 4G spectrum award Ofcom stated:

"Our proposals to promote competition were likely to drive wide availability but felt that they should be underpinned by a minimum coverage obligation to ensure that a future mobile broadband service would be provided to a significant proportion of citizens and consumers on a reasonable timescale".

3.24 Coverage obligations on the radio spectrum licenses which Ofcom grants the MNOs have been the principal public mechanism used to drive the market to improve. These obligations are often offset against the cost of licenses – in effect a public subsidy. Looking over the history of UK coverage obligations (See Coverage interventions in the UK) shows how over the last decade these have increased in terms of their stretching nature and ambition, reflecting the increasing importance of widespread mobile access to the public and policy makers.

Coverage interventions in the UK

Coverage obligations are a major part of telecoms regulation and are imposed by governments in many countries. However, measuring coverage and monitoring compliance can prove difficult (see "Define coverage"), and approaches vary.

The 3G auction in 2000 imposed an 80% coverage obligation by the end of 2007, which was met by four of the five operators at the time. O2 failed to meet the target by nearly five percentage points, and Ofcom threatened to shorten O2's licence as a result. After a few months of increased investment, O2 improved the coverage to meet the obligation by June 2008, and Ofcom confirmed that at the end of 2008, all operators have met the 80% threshold.

The coverage obligation was later raised to 90% in 2011, and Ofcom announced that the new obligation was met in June 2013 by all operators except Vodafone, which reached it six months later. The two cases in which an operator failed to reach the threshold (but was forced to do so quickly afterwards) imply that coverage obligations have indeed been an effective policy tool. This is reinforced by Ofcom's view that the original obligations could have been higher to begin with and it would have benefitted consumers.

The 4G auction obligations were set at a higher level to reflect this lesson (98% population coverage by end 2017), but it was imposed on one licensee only. It was expected that the other operators would feel commercial pressures to match the coverage levels delivered by the operator with the coverage obligation. Operators later confirmed their plans to achieve this.

While at the time of the 4G auction the coverage obligation appeared to be stretching, there was a continuing concern that the coverage levels delivered by the MNOs fell short of consumers' expectations, especially in relation to geographic coverage (although networks had not at this point fully rolled out their 4G networks). This led to an agreement between Government and the operators to raise geographic coverage to 90% by area (which implies a much greater coverage by population) by 2017.

Meaningful coverage: looking to the future

3.25 The coverage levels that MNOs advertise, however, and which are discussed in policy terms are often not based on meaningful measures. Only with an honest and understandable picture of service quality can consumers hope to make informed purchase decisions and policy makers target the right issues.

3.26 The UK does not compare well internationally, being firmly middle of the pack on coverage and speed. If the UK is to move into a leading role, where it is recognisably ahead of peers in terms of the quality of mobile connectivity, this must change. Provision of the fundamental wireless infrastructure in hard to reach areas (ducts, fibre, masts & poles) is one useful means to enable widespread and early deployment of new generations of mobile technology. This is a helpful area for government to support and the Commission welcome the 5G enabling measures recently announced in the Autumn Statement. The push for seamless and ubiquitous connectivity must not wait for 5G, instead immediate action is needed to improve mobile coverage for users now and to help build a foundation which will enable widespread access to 5G services in future.

3.27 Although mobile services are increasingly a necessity rather than a luxury, the UK currently operates without a clear definition of the services that should be provided at near ubiquitous levels ("the essentials") versus those which are more discretionary. This makes it difficult for interventions to be targeted around agreed and transparent expectations.

3.28 There are three key areas to address:

- coverage that does 'what it says on the tin' – addressing the gap between modelled and actual coverage;
- identifying defined "essential" services that are expected to be widely available, which will enable clarity and transparency on expectations around mobile coverage quality for the future in the UK; and
- identifying a strategy to tackle partial-not spots.

3.29 There is a strong case for a wholesale shift away from the use of predicted residential coverage as a benchmark for mobile services. This is likely to mislead consumers when so much of their mobile experience is based elsewhere – on transport networks, around businesses, towns and villages. The advent of smart-phone data analytics means vast quantities of data are available, based on real user experience, which can be linked much more accurately to the services used. Widespread adoption of realistic measures of user quality of service and coverage are necessary if consumers are to drive competition through purchasing decisions.

The Commission believe it is time for a wholesale shift away from the use of predicted residential coverage as a benchmark for mobile services.

3.30 In the interim, Ofcom has a strong capability to measure real coverage through its field force, demonstrated in some of its more recent reports, such as Smart Phone Cities.[65] This could well form the basis of enforcing more measurable service based obligations and policy interventions going forwards, and ensuring coverage levels cited in advertising can be validated through spot testing of network performance. This approach should enable valuable progress in the short term, while a longer term plan is developed to use data collected from networked devices such as smartphones.

3.31 The definition of 'essential' mobile communications might cover the ability to be able to make calls, send messages, and access basic internet services – such as web browsing, maps and navigation assistance. This could form the basis of transparent messaging around coverage expectations, advertising, policy interventions and enforcement.

3.32 A fairly basic level of "essential" service is likely to imply a 256kb/s or 500kb/s level of connectivity, though it will almost certainly rise in the future. Establishing this "essential" layer will enable competition in the future to drive service quality based on network speed and capacity, rather than coverage which denies users' further insight into quality of service. Whilst, many consumers may well be satisfied with a level of service provision meeting these 'essential' standards, others will demand more, which the market should be well able to provide.

3.33 The level of "essential" services would need to evolve over time as technology changes and new services are taken up and embedded within society. As well as the current view of "essential" standards, a forward view across the next 5 and 10 years would provide transparency about the government's coverage objectives. Terms like "4G coverage" or "5G coverage" do not help in this regard, as they are technologies, rather than indicators of particular services consumers can use.

3.34 Addressing these points will provide a more honest picture of mobile service quality in the UK, as well as enabling more informed purchase and switching decisions and more informed and targeted policy interventions; and providing transparency about the services that consumers should be able to expect from the mobile operator ecosystem on a widespread basis – wherever we live, work and travel.

Establishing coverage where we live work and travel

3.35 Partial and complete not-spots are persistent and substantial issues in the UK, which are incompatible with long-term expectations for a connected society.

3.36 There are a number of ways this situation can potentially be addressed in areas where the market is not driving an adequate solution. These include:

- enabling roaming between networks;
- enabling multi-operator MVNO's who can aggregate coverage from the wholesale providers;
- procurement of the service level;
- coverage obligations;
- or a combination thereof.

3.37 These approaches, which have been considered previously by others, are covered in more detail in our reported research.[64]

3.38 By the end of 2017, the mobile operators are expected to have delivered their obligations on voice coverage to 90% of the UK geographic landmass and 4G coverage to 98% of homes (O2 only). It is not clear, however, how those obligations relate to the real service level consumers can expect and to what extent this will resolve issues around partial not-spots. It therefore remains to be seen whether the combination of the two existing coverage obligations will, when fully rolled out, be sufficient to meet an "essential" service level across all operators.

3.39 Any future obligation or procurement to address mobile coverage using the approaches mentioned must be coherently thought through by Government and Ofcom and where possible avoid proliferating the patchwork of differing obligations further. This should consider the precise definition of delivering "coverage where we live, work and travel" For example does it mean 95%, 98% or 100% of our road network.

3.40 The Commission call for a coherent review and recommendations on the right approach to deliver ubiquitous essential service coverage from mobile networks, and also the market enables high quality for users of mobile networks. This should take a long term view and make recommendations around 4G and 5G, as well as reflecting the contribution of unlicensed technologies be they Wi-Fi/4G or 5G.

3.41 Establishing near universal mobile coverage now means the foundation for widespread 5G services is laid. The evidence that the Commission has considered suggests that without any intervention we can expect 5G to roll out similarly to 4G in the UK; it will roll out in urban areas first, followed by rural areas later; outside of urban areas we can expect patchy coverage, including on our roads and railways, and with some areas receiving no coverage at all. We should expect 5G services to be delivered in a middle, rather than a leading timescale. To avoid this picture means building the right infrastructure by our motorways, railways and fixing not-spots in rural areas now.

Recommendation 5: Government and Ofcom should develop a meaningful set of metrics that represent the coverage people actually receive and use these to determine a mobile universal service obligation setting out the minimum service level people should expect to receive.

a) **Ofcom, government and mobile operators should report their coverage so that they are genuine and meaningful reflections of the services enjoyed by customers. Metrics should be measurable and based on the reality of service and coverage provided to customers, not based on simulated or predicted performance. Ofcom should set out how this is best achieved by the end of 2017.**

Ofcom and government should use these metrics as the basis of future interventions such as spectrum licence obligations or voluntary agreements with operators.

Government, Ofcom or the Advertising Standards Authority should take action if operators advertise or report coverage in a way that does not reflect services being delivered to consumers on an everyday basis.

b) **Mobile services are increasingly viewed as essential, underpinning our daily lives and the digital economy. Government must deliver a view by the end of 2017 on what aspects of mobile services are considered "essential". It should then establish how this "essential" level of service provision can be made available through a mobile universal service obligation regardless of the network to which a customer is subscribed. Government should engage with Ofcom and industry to establish the best delivery mechanism, whether through spectrum licence obligations, enabling roaming, enabling cross operator Mobile Virtual Network Operators (MVNOs), through government procurement or a mix thereof.**

Government with the assistance of Ofcom should deliver this as soon as is practical but no later than 2025.

Regulation that is fit for the future

3.42 The regulatory framework for mobile telecommunications has helped to deliver good outcomes in the UK. Whilst significant changes have been seen in the UK market across the last decade, it remains highly competitive, with four MNOs and 17 active Mobile Virtual Network Operators (MVNOs), which help to foster competition by establishing agreements to use existing MNO infrastructure in order to provide more diverse customer products and services. As a result, consumers have enjoyed innovative services and pricing in recent years; indeed UK prices are among the lowest in Europe, and the cost of a typical package has fallen by two-thirds since 2003. By the end of 2015, mobile subscriptions had reached 91.5 million and were continuing to grow. And, following some years of decline in revenues, the market has been stable for the last three years.

3.43 As set out previously in this report, the UK remains in the middle of the pack in terms of delivery of world class, high quality mobile services. If we wish to move to a leading position, regulation which looks to the future and also enables the necessary investment in the UK market is critical.

Key developments in the mobile market

3.44 The mobile eco-system has continually evolved to reflect changes in technology, the increasing demands of users, and operational efficiencies in a maturing market. Over the last 15 years, the market structure has evolved from one where MNOs were vertically integrated, controlling a large part of the value chain from owning and operating the network to retailing services and handsets to consumers, to a more complex structure with a number of players operating in parts of the value chain such as application providers and wholesale infrastructure providers.

3.45 These trends are set to continue. Looking to the decade ahead there are a number of possible developments that will influence the deployment of future mobile telecoms networks.

- **Ongoing financial pressure on MNO's and investment.** The ability for third parties to create applications for mobile phones has generated an explosion in services and data, demand forecast to continue grow rapidly into the future. This creates the challenge around investing in network infrastructure and technology to meet demand, while revenues from the apps do not necessarily flow to the MNOs. Mobile operators have also seen little willingness to pay more for new generations of mobile technology such as the move from 3G to 4G.
- **A greater pressure to share infrastructure.** This is likely to be necessary to reduce capital and operational costs for establishing coverage in less profitable areas required for ubiquitous coverage, and potentially for providing the ultra-dense 5G network deployments envisaged. Neutral hosting models are one way to facilitate infrastructure sharing.
- **Further reduction of vertical integration and control.** While the MNOs may remain key investors in mobile infrastructure, 5G technology developments such as network virtualisation and cost efficiencies mean that the level of vertical integration could fall further:
  - MNOs could outsource elements of the core network to cloud computing providers;
  - Application providers and retail providers could offer services over their own 'network slices', having greater control over quality of service than under existing wholesale MVNO agreements; and

- Retail providers could combine services from several networks to provide seamless services. Examples of this are already being introduced, (such as Google's Project Fi which shifts intelligently between networks to the best available signal) though current technology means that services attempting to stitch together separate networks are sub-optimal, for example not being able to manage a seamless handover when operators move between different networks. Technology is moving rapidly however with seamless handover from Wi-Fi to 4G for example now mainstream.

- **A push to smaller, higher capacity cells and potentially more local network provision.** Very high capacity connectivity pushes to very high frequency small cells in millimetre wave bands. These are unlikely to be deployed on a national coverage basis. However, there may be opportunity for other smaller providers alongside the existing four national wholesale operators to contribute to widespread 5G deployment by adding to the UK's telecom infrastructure.

3.46 The future changes to the mobile telecoms market suggest that mobile operators will be a key part of 5G deployment, but may well not be the only players providing digital infrastructure. For 5G to emerge in a timely manner regulatory options for the future need to enable continued investment to flow into mobile infrastructure through MNOs and other infrastructure providers, as well as enable the market to evolve as it has over the last decade.

3.47 A key consideration for regulation to address therefore is enabling investment by encouraging the maximum amount of infrastructure sharing that is possible while maintaining an appropriate degree of competition. This will minimise capital and operational expenditure for both the infrastructure needed to provide coverage in hard to reach areas and also for highly dense networks. Secondly enabling wide access to the market for new and possibly sub-national infrastructure providers and to enable innovation means looking hard at whether dedicated spectrum licensing is the right option.

Infrastructure Sharing

3.48 When making investment decisions operators must balance costs and benefits, including benefits of that might come from differentiating themselves from their competitors. Reducing the costs of network deployment will increase the operators' incentive to make incremental investments in their networks; whether to extend existing network capacity and coverage or to introduce 5G specific technology.

3.49 A considerable degree of sharing already occurs in UK mobile networks as is clear from the formation of the network sharing companies MBNL and CTIL, as well as through the existence of dedicated wireless infrastructure providers such as Arqiva and WIG. The current network sharing arrangements reduce the cost of coverage for operators, reducing some fixed costs by half (with two operators sharing site infrastructure).

3.50 It has been estimated that network-sharing could potentially lead to overall cost savings for an MNO of up to 15% through mast-sharing and 30% through RAN-sharing. To date network sharing agreements have been approved by competition regulators as they still provide scope for operators to differentiate in terms of different dimensions of network quality and thus provide incentives for investment.

3.51 Costs could be further reduced if all operators shared sites. While this is encouraged under existing regulation (see breakout), and can be facilitated by Wireless Infrastructure Providers (WIPs) acting as neutral hosts, in many cases co-ordination issues mean that each network sharing agreement (CTIL and MBNL) rolls out duplicate sites. There are difficulties in enabling this co-ordination without providing adequate incentives for the stakeholders to align, for example incentives to roll out increased coverage networks.

Infrastructure sharing in the Electronics Communications Code (ECC)

The ECC states that operators should share infrastructure where practicable. This can involve sites, towers, masts or radio access equipment. Ofcom therefore requires applicants applying to be Electronic Communications Code operators to show that they are willing to share their apparatus with other operators. The objective is to minimise both the inefficient duplication of network infrastructure and the visual impact of telecommunications equipment. Sharing can also be attractive to operators as the fixed-costs of network deployment can be shared. However, practical difficulties in sharing infrastructure or strategic reasons may deter operators from entering into agreements for individual pieces of infrastructure (compared to network sharing agreements at a national level). A "first mover advantage" would be an example of incentivising investments which are not shared. For example In order to be first to the market with 4G, EE chose to roll out its 4G network independently of Three.

While the reform of the ECC reduces costs for MNOs in a number of areas, a potential stumbling block could be that the revised Code will not regulate the fees charged by Wholesale Infrastructure Providers for their sites. This may need review moving forward as WIPs owned approximately one third of mobile towers/rooftops as of May 2016.

3.52 While further network sharing, in its extreme form through the formation of a single wholesale network, could lead to higher cost-savings still, the element of network competition would be lost and there may be fewer incentives to innovate. The GSMA found[66] that countries with network competition were much faster in introducing new technologies than countries with single networks, with major network upgrades coming 1 to 2 years later in single network countries. Innovation is vital in a rapidly changing hi-tech sector such as telecoms.

3.53 Both the cost savings and the potential loss in competition at the wholesale level would therefore need to be considered if a decision of deeper sharing is to be made.

3.54 It is possible that in meeting the need to increase the number of sites under 5G networks, whether to increase capacity in urban areas or to increase coverage in particular areas, rolling out a number of parallel infrastructures may not be efficient, or even physically possible (e.g. rolling out tens of thousands of small cells in densely populated areas). Thus there may be a role for increased network sharing in specific areas, even if operators maintain the existing level of network competition in general.

3.55 Similarly, in areas with no mobile coverage (which operators consider uneconomic to serve), a common set of infrastructure for the four MNOs would, in principle, minimise costs of network roll out. However, these cost savings might still not be sufficient to incentivise the operators to serve these areas.

3.56 The onus therefore may be on improving incentives for infrastructure sharing to reduce the cost of greater coverage requirements. There are a number of ways this could be achieved – coverage obligations, roaming, enabling multi operator MVNOs, or tendering a universal service obligation. When determining the appropriate approach to deliver a USO, enabling the maximum levels of infrastructure sharing possible should be considered.

3.57 Wholesale only infrastructure providers (sometimes called vertically separated infrastructure providers) have different incentives to vertical MNO infrastructure holders. With appropriate regulation establishing fair, reasonable and non-discriminatory terms for access this model of infrastructure provision could be a valuable means of lowering the friction and cost associated with providing mobile services. There are opportunities for following this approach in the provision of digital infrastructure alongside our motorway network and roads, the trackside infrastructure along our railways, rural areas and potentially for local authorities and others who might choose to invest in 5G.

3.58 The Commission sees independent infrastructure providers as potentially an enabling mechanism for meeting some of the remaining challenges around deployment of 4G and 5G connectivity. Regulation should encourage and enable such provision where possible to maximise the ability for the market to meet some of the challenges around deployments of both dense networks and rural networks.

Recommendation 6: By the end of 2017 Ofcom and government must review the existing regulatory regime to ensure that it supports the sharing of telecoms infrastructure. This will be particularly important for areas of the country where competition driven markets have struggled to provide the necessary mobile infrastructure.

Enabling subnational provision of services: the role of spectrum policy

3.59 Spectrum policy is intimately tied to market economics in mobile communications. Whether you have a license to access parts of the radio spectrum defines in the main whether you can offer services. The small number of licenses granted, governing access to this scarce resource tends to limit the number of market players. Across the world we see mobile operators operating in a national oligopoly market. This in part enables the very large investments required to roll out, operate and upgrade nationwide networks.

3.60 Spectrum auctions have become the most prevalent method for allocating the scarce resource through spectrum licenses to market players such as the MNOs. This is because:

- they are seen to act as an efficient means to allocate a resource to a variety of market players with potentially differing uses. A party who is willing to bid most for the resource is the one who values it most for driving their future business; and
- they raise money for governments.[65]

3.61 There are a number of ways spectrum policy can influence outcomes for 5G deployments in the UK. Costly spectrum licenses can limit the market to major oligopoly players. Most of the spectrum which is usable (either currently or in the near future) for mobile devices such as iPhones and Android phones is valued very highly by existing national mobile operators. Others in the market, for example small scale providers, are unlikely to be able to raise sufficient investment to outbid a national player and thus spectrum access for them becomes a challenge.

3.62 Spectrum auction fees – often hundreds of millions of pounds – and ongoing annual license fees are another cost which makes business cases more of a challenge for operators and investors faced with uncertain decisions such rolling out infrastructure for new technology markets.

3.63 The very high frequency millimetre wave bands proposed for 5G may not need such tight regulation. Alternative licensing approaches such as unlicensed or light licensing (see breakout box below) may be appropriate. These approaches reflect that the need for licensing is reduced by technology managing interference, or reducing it to an extent which operators can manage through a code of practice. This potentially drives much greater spectrum use than allocation of dedicated rights to players who then may make use of spectrum in just a small number of areas. Balancing the availability of unlicensed as well as licensed spectrum in the market enables innovation as well as enabling appropriate investment certainty for established players.

3.64 5G is seen as providing hot spots of super high capacity, not necessarily uniform wide areas coverage, or coverage on a nationwide basis. Unlicensed or light licensed spectrum access could enable smaller scale players to enter the market and contribute to particular localities, or for businesses to self-provide. For example:

- Factory owners may choose to purchase 5G capability for their factories – controlling robots. They may do this either from a mobile operator, or a smaller niche provider, or indeed choose to self-provide. It can be seen that if 5G spectrum is held by and only accessible to mobile operators the latter two cases are not possible.
- Councils, communities or business park owners may choose to deploy 5G hotspots in a locality providing ultrafast wireless broadband or coverage for IoT uses or sensor networks.
- Sub-national fibre companies (alt-nets) rolling out fibre to rural communities may wish to provide 5G services in those areas making maximum use of their deployed fibre assets.

Licensed and Unlicensed Spectrum

Spectrum is a finite natural resource. Historically spectrum licensing has been required to manage the potential for wireless operators to interfere with each other and impact their ability to provide services. Spectrum licenses take slices of the radio spectrum and allocate them to individual operators and uses to eliminate the interference risk.

Technology is moving rapidly in a direction where such regulation is looking archaic. Modern technology is increasingly able to manage interference, and the interference risk itself diminishes as technology pushes to the ever higher frequencies expected to be used for 5G. The very high data rate communications envisaged by 5G and other technologies also requires access to much wider parts of the radio spectrum than can be efficiently licensed to one operator.

Other approaches to licensing are available that allow potential entrants to use the spectrum without making the necessary investments to outbid MNOs in a spectrum auction. They also reduce spectrum costs (as unlicensed spectrum is free of charge) and potentially increase spectrum utilisation as more than one user would can have access to this spectrum.

Wi-Fi is an example of unlicensed spectrum being used successfully to enable global innovation. While MNOs still have a pivotal role in providing wide area coverage when customers are 'out and about'. The majority of traffic to mobile devices is now delivered by Wi-Fi networks rather than traditional mobile networks.

Unlicensed spectrum is also enabling innovation in the IoT space. Sigfox and LoRa are two IoT technologies which use unlicensed spectrum to provide services and have already started rolling out networks in the UK. Sigfox has partnered with Arqiva in the UK to roll-out an IoT network and LoRa installed their first base station in London in early 2016. With the number of connected devices predicted to reach billions, these dedicated networks are likely to expand and benefit from their own economies of scale. These networks in turn drive competition in standards and are likely to incentivise MNOs to upgrade their own M2M/IoT capabilities from 2G and 3G to LTE and ultimately 5G.

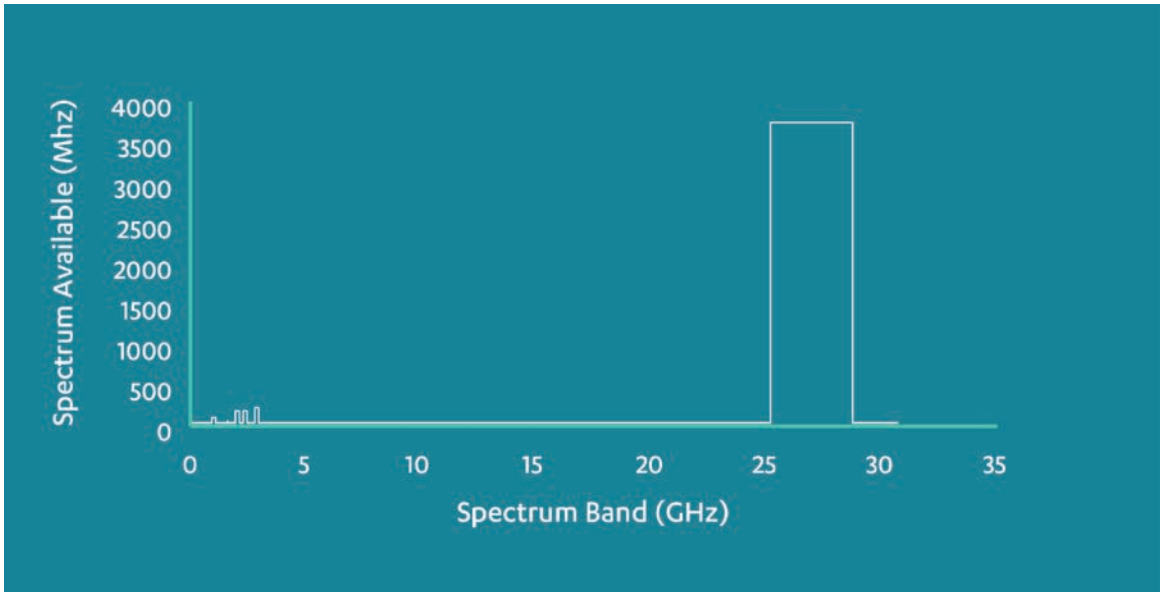
What is millimetre wave spectrum, and why does 5G need it?

5G technology is looking to use both traditional radio spectrum bands currently used in mobile communications and much higher frequency bands – termed millimetre wave bands

The amount of data that can be transmitted wirelessly is proportional to the amount of radio-spectrum you are transmitting over. Historically technology has only been able to operate at low frequencies where there is limited spectrum bandwidth available. As time has moved on, ever higher frequencies of the radio spectrum have become accessible, meaning greater spectrum bandwidth has been able to be exploited by mobile operators for increase data rates.

Technology has now enabled access to the very high frequency millimetre wave bands of the radio spectrum. The components and signal processing required to make efficient radios have moved from the research community into mainstream manufacture. The large amounts of spectrum bandwidth necessary for the high data rates that 5G seeks to supply are only available at these higher parts of the radio spectrum.

In 2016 in the UK the total holdings of the four mobile operators are approximately 600MHz. By comparison just one of the anticipated 5G bands offers potentially 3500MHz of spectrum.



Unfortunately radio waves at such high frequencies do not propagate as well as at lower frequencies, meaning distances over which communications is possible are much more limited – potentially limiting the area mobile cell can cover to just 100m or 200m. Whilst such small cells create an infrastructure a challenge, it does mean the base station data capacity is shared between a small number of users, offering potentially vast data rates.

3.65 This direction of travel is supported by evidence in the UK and abroad. The US has taken the approach of releasing considerable amounts of both licensed and unlicensed spectrum for 5G services. In the UK, Vodafone recently commented on their openness to the possibility of less restrictive licensing approaches to the millimetre wave 5G spectrum bands.[67]

3.66 Where spectrum licensing is considered essential (at lower frequencies) obligations on licensees may be a good thing in terms of driving infrastructure provision and minimising costs to operators. They act as a public subsidy for infrastructure provision – bidders subtract the cost of fulfilling the obligation. In theory they can result in spectrum licenses being awarded for zero cost or negative cost if onerous obligations cost more to fulfil than the value of the spectrum.

3.67 One way of driving early 5G deployment in the UK would be to put an obligation on the 3.4GHz licenses which is the first "5G" spectrum to be released to the market in the UK. An obligation could for example require an operator to deploy 5G equipment on all masts within its current network.[66] This would be a radical departure from technology neutrality which is usual in spectrum policy, but it serves to demonstrate how spectrum licenses can subsidise early rollout if that is the policy objective.

3.68 In summary, as well as lower frequency radio spectrum, 5G expects to make use of very high frequency millimetre wave radio spectrum, resulting in very small mobile cells. These are not anticipated to be deployed outside of urban centres by mobile operators. Auctioning spectrum licences in large, national scale blocks, at these very high frequencies, risks a significant share of the radio spectrum lying fallow in large parts of the country where it is not profitable for operators to deploy networks, yet would be closed off to other uses. This acts as a barrier to entry for new firms to compete in the provision in mobile services and may impede the most widespread deployment of 5G high frequency small cells.

3.69 Spectrum sharing or much less restrictive access to higher frequencies could be a highly efficient way to ensure a number of operators can provide connectivity, making best use of the scarce resource. We think Government and Ofcom should review how unlicensed, light licensed spectrum, sharing and associated approaches can be utilised in high frequencies to maximise access to the radio spectrum beyond the 4 national wholesale operators. This will stimulate maximum innovation and could result in the reach of 5G being maximised.

3.70 Ensuring the right balance of unlicensed, light licensed and sharing with traditional licensed approaches is likely to stimulate maximum innovation and could result in the reach of 5G being maximised.

Recommendation 7: Ofcom and government must ensure they keep pace with the rapid evolution of the mobile communications market, and that the regulatory regime is fit for purpose. By the end of 2017 Ofcom and government must review the regulatory regime to ensure that spectrum allocation and regulatory decisions support a growth model in a world where technology developments enable greater shared access and interoperability. Government and Ofcom should review how unlicensed, lightly licensed spectrum, spectrum sharing and similar approaches can be utilised for higher frequencies to maximise access to the radio spectrum. Spectrum decisions should where possible enable:

- Community or small provider solutions to meet the needs of local areas if they remain unserved or poorly served.
- Niche entrants or sub-national players to access the higher frequency spectrum anticipated for 5G. Allocation of nationwide spectrum licenses to a small number of operators could leave large areas of the UK fallow.
- Businesses, universities and others to access spectrum where they need to within their factories or buildings, including already licensed spectrum if there are no interference risks. This will unlock multiple wireless service provider options, including self-provision, spurring the innovation in industrial internet of things, wireless automation and robotics.

THE NATIONAL INFRASTRUCTURE COMMISSION



Chair

Lord Andrew Adonis

Lord Andrew Adonis was appointed as chairman of the National Infrastructure Commission on 5 October 2015. He was a member of the independent Armitt Commission, which recommended an independent National Infrastructure Commission in 2013.

Andrew Adonis was formerly the Transport Secretary from 2009 to 2010, Minister of State for Transport from 2008 to 2009 and Minister for Schools from 2005 to 2008. He was Head of the No10 Policy Unit from 2001 to 2005.

Deputy Chair



Sir John Armitt

Sir John Armitt is Chairman of the National Express Group and City & Guilds, Deputy Chairman of the Berkeley Group and a member of the Board of Transport for London, Senior Vice President of the Institution of Civil Engineers and a Fellow of the Royal Academy of Engineering, the Institution of Civil Engineers and City & Guilds of London Institute. He has received honorary doctorates from the universities of Portsmouth, Birmingham, Reading and Warwick and was awarded the CBE in 1996 for his contribution to the rail industry and a knighthood in 2012 for services to engineering and construction.

In September 2013 the Armitt Review, his independent review of long term infrastructure planning in the UK, was published. The review is now Labour Party policy.

Commissioners



Tim Besley

Tim Besley is School Professor of Economics and Political Science and W. Arthur Lewis Professor of Development Economics at the LSE. He was a co-chair of the LSE growth commission and a member of the IFS's Mirrlees Review panel, and is currently Chair of the Council of Management of the National Institute of Economic and Social Research.



Demis Hassabis

Demis Hassabis was the co-founder and CEO of DeepMind, a neuroscience-inspired AI company, bought by Google in Jan 2014. He is now Vice President of Engineering at Google DeepMind and leads Google's general AI efforts.



The Rt Hon Lord Michael Heseltine CH

The Rt Hon the Lord Heseltine CH was a Member of Parliament from 1966 to 2001. He was a Cabinet Minister in various departments from 1979 to 1986 and 1990 to 1997 and Deputy Prime Minister from 1995 to 1997. He is founder and Chairman of the Haymarket Group, and most recently was appointed by the government as an advisor to the Secretary of State for Communities and Local Growth.



Sadie Morgan

Sadie Morgan BA (HONS), MA (RCA), FRSA is a co-founding director at the award-winning practice, dRMM Architects. She became the youngest and only third ever-female President of the Architectural Association in 2013. In March 2015, Sadie was appointed as Design Chair for High Speed Two (HS2) reporting directly to the Secretary of State.



Bridget Rosewell

Bridget Rosewell OBE, MA, MPhil, FICE is a UK economist, with a track record in advising public and private sector clients on key strategic issues. She is a founder and Senior Adviser of Volterra Partner and a non-executive director of Network Rail and of Ulster Bank. She was Chief Economic Adviser to the Greater London Authority from 2002 to 2012. She has been a member of several Commissions looking at the future of public services, cities, infrastructure and local finance.

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2 There are a further c.1,900 miles of trunk roads in Scotland and around 1,000 miles of trunk roads in Wales.

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4 Rail delivery group. "GB rail: better services, better journeys and better value" http://www.raildeliverygroup.com/files/Publications/2015-09_rail_industry_dataset.pdf

5 See http://orr.gov.uk/__data/assets/pdf_file/0015/22056/passenger-rail-usage-2015-16-q4.pdf

6 In December 2014, the UK Government signed a binding agreement with the four network operators to improve mobile coverage. This was aimed, in particular, at reducing 'partial not spots', where coverage is provided by some but not all mobile operators. This agreement guarantees coverage of a mobile voice and text service from each operator to 90% of the UK's land mass by 2017. This is expected to improve with the future availability of voice services over the 4G networks operating in the lower 800MHz band.

7 It should be noted that O2 has a coverage obligation in its licence to roll out 4G to cover at least 98% of the UK population (when indoors) by 2017 at the latest. This results in more than 99% coverage for 4G when outdoors. Other UK mobile operators have indicated they intend to match the 98% coverage.

8 Ofcom, press release, 'UK is now a smartphone society', 2015, https://www.ofcom.org.uk/about-ofcom/latest/media/media-releases/2019/cmr-uk-2015

9 World Economic Forum White Paper, 2016. See: http://reports.weforum.org/digital-transformation-of-industries/wp-content/blogs.dir/94/mp/files/pages/files/digital-enterprise-narrative-final-january-2016.pdf

10 Capital Economics Research commissioned by Everything Everywhere. http://www.ibtimes.co.uk/4g-everything-everywhere-75bn-lte-economy-334922.

11 See: http://www.cbi.org.uk/news/infrastructure-survey-2015/infrastructure-survey-2015/ . Similarly, the Federation of Small Businesses recently found that three quarters of small businesses believe mobile phones are crucial or very important to their business FSB http://www.fsb.org.uk/media-centre/publications?page=13

12 See, for example: Economic Impacts of Mobile Communications in Scotland, Report to the Scottish Government, SQW, January 2014, though there is a counter view that questions the true economic value of features such as increased bandwidth. See: Kenny, R. and C. Kenny (2011). "Superfast broadband: is it really worth a subsidy?" info, 13(4): 3–29.

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21 Understanding 5G: Perspectives on future technological advancements in mobile, GSMA, December 2014

22 WIPs also include: WIG, which operates a network of over 2,000 shared communication infrastructure assets act as intermediaries between landlords and MNOs (leasing land for sites and renting those sites to MNOs). They also build common infrastructure on sites which can then be shared between MNOs and other providers of radio based services. And, Shere, which owns approximately 500 sites in the UK with access to 4,150 potential sites on land belonging to United Utilities and Thames Water

23 Frontier for NIC, citing analysis produced by Analysys Mason

24 As of September 2016. Source: Globalcomms

25 Frontier for NIC, 2016

26 Ofcom Market Report, 2016 http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr16/uk/CMR_UK_2016.pdf

27 Linked to this narrative of increased mobile data usage is an increase in the number of Machine to Machine (M2M) connections, which increased by 7% between 2014-15, to a total of 6.7 million in 2015; whilst still relatively modest, this is a sign that the IoT has arrived. See: Ofcom Market Report, 2016 http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr16/uk/CMR_UK_2016.pdf

28 Ibid

29 5G networks will be capital intensive due to the need for a significant increase in small cells to realise many of the predicted 5G benefits. High frequency 5G technologies will only propagate across tens to hundreds of metres, which will necessitate 'densification' of small cells.

30 Research by RealWireless for NIC, 2016. See also – 'Identification and quantification of key socio-economic data to support strategic planning for the introduction of 5G in Europe', prepared for the European Commission DG Communications Networks, Content and Technology, 2016, page 9

31 Research by RealWireless for NIC: These areas are taken from a comprehensive long list of potential candidates, and alone illustrate the diversity of potential uses that are envisioned for future mobile services and suggest at the consequent demand that will be placed on future mobile network infrastructure.

32 Connected and Autonomous Vehicles – Opportunity March 2015

33 By 2030, some consider it likely that high degrees of automation will be seen during certain vehicle operations, for example, motorway 'autopilot', but not for the full end to end journey, which is expected at some point beyond 2030. See KPMG: https://www.smmt.co.uk/wp-content/uploads/sites/2/CRT036586F-Connected-and-Autonomous-Vehicles-%E2%80%93-The-UK-Economic-Opportu...1.pdf

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37 See – Personalised health and care 2020: a framework for action, Department for health, 2014

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39 For example, 1. Diabetes UK estimate there are over 4 million people in the UK living with diabetes, an increase of 65% over the past decade. The UK also has the highest obesity level of European with nearly 1 in 4 adults classed as obese in 2008. In addition, mental illness is becoming an increasing issue with more than a quarter of hospital inpatients in 2014-2015 suffering from dementia.

40 A further future envisaged use case for remote healthcare is 'remote surgery' via the Tactile Internet. However, there is considerable uncertainty over what tactile internet applications will emerge and whether they will be taken up in the short to medium term, especially given questions over consumer acceptance. Given that the UK population has good access to medical facilities, the need for remote surgery is unclear.

41 Analysis for NIC by Frontier Economics, 2016

42 See the recent report regarding mobile coverage in the UK by the British Infrastructure Group: http://britishinfrastructuregroup.uk/wp-content/uploads/2016/10/Mobile-Coverage.pdf

43 Roads Investment Period 1, Plan, 2015

44 Analysis by KPMG in 2015. See: https://www.kpmg.com/BR/en/Estudos_Analises/artigosepublicacoes/Documents/Industrias/Connected-Autonomous-Vehicles-Study.pdf

45 A number of trials are underway: The UK Connected Intelligent Transport Environment (CITE) connected vehicle trial by April 2018, which includes Jaguar Land Rover, Coventry City Council, Visteon, Vodafone and others – a project sponsored by Innovate UK; The A2/M2 Connected Corridor, with partners including DfT, Highways England, Transport for London and Kent County Council and supported by the Automotive Electronic Systems Innovation Network; And an HGV platooning, announced in Budget 2016.

46 Where the density and volume of traffic is likely to cause spectrum capacity issues in the near to mid-term and where technology can help realise innovations such as vehicle platooning.

47 MNOs have told the NIC that this is often due to the additional complications, access restrictions and expense of placing base stations on the trackside.

48 All operators are all equally affected by trackside access difficulties and many rail routes travel through areas of low population density with limited existing infrastructure (such as power, fixed networks and access roads) driving the investment required to support mobile networks up.

49 For example, until new Franchise Agreements were introduced recently, TOCs were not incentivised to provide connectivity on trains. Moreover, Network Rail was not incentivised to allow MNOs to place masts close to rail tracks (for personnel safety reasons).

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58 Mobile Coverage: A Good Call for Britain, British Infrastructure Group, Oct 2016. http://britishinfrastructuregroup.uk/wp-content/uploads/2016/10/Mobile-Coverage.pdf

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62 The Communications Market Report, 2016, Ofcom

63 EE 4G network summary, EE website, December 2016

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LONDONASSEMBLY

Regeneration Committee

Holding the Mayor to account and investigating issues that matter to Londoners

Digital Connectivity in London

June 2017

London's economic productivity and international competitiveness face a significant threat in the form of poor digital connectivity. The capital is poorly served, suffering from 'not-spots', 'digital deserts' and a lack of fibre connections. Because big telecommunications companies have struggled to deliver for the capital's businesses and residents, London lags behind smaller UK cities such as York, Coventry and Edinburgh despite its role as a global competitive city. These cities are all significantly better connected, being 'Gigabit Cities' where download and upload speeds reach 1,000 megabits per second (Mbps). Across Europe, London also performs poorly, ranking 26 out of 33 capital cities in 2014 for its average download broadband speed.[1]

The London Assembly Regeneration Committee took evidence from London residents, local authorities, businesses and internet providers to understand what is needed, in terms of digital connectivity, for London to remain an inclusive and attractive place to live and do business.

This report collates these views into a set of priorities that should shape the Mayor's new digital strategy and the action of the future Chief Digital Officer.

If you have any comments or would like to find out more, you can get in touch via Julien.Danero-Iglesias@london.gov.uk.

Digital Connectivity: What is it and why does it matter?

Digital connectivity is about access to fast and reliable internet connection (fixed or mobile) which enables users to benefit from smart and digital services. [2] It is the 'fourth utility', an everyday necessity alongside water, gas and electricity.

Superfast broadband can be a useful indicator for measuring a place's digital connectivity.[3] Superfast fixed broadband of 24 Mbps or more[4] is likely to be needed in households where different people use the internet at the same time, download films or large files on a regular basis, use multiple devices to access online services, play video games or use video calling services.[5] Superfast fixed broadband enables small and medium enterprises to do more for less, is better value for money, and is more cost effective than regular broadband provision. Facilitating Skype and Cloud computing, it helps reduce the need to travel, and as a result reduces overheads, provides greater convenience, saves time, ultimately reducing carbon footprints and improving efficiency and work/life balance.[6] With a 24 Mbps superfast connection, downloading a 25MB file would take about 10 minutes. In comparison, it would take about 20 minutes with a 10 Mbps connection and about 10 seconds with a gigabit connection. Data consumption is growing at around 50

Digital Connectivity in London

per cent or more per year[7] and the 10 Mbps deemed currently enough for an 'acceptable user experience' may soon not be for most.[8]

At the same time, mobile broadband is, and will continue to be, an essential complement of fixed broadband. For 71 per cent of small businesses, mobile phones are crucial or very important to their business.[9] London must invest in, and prepare for, the next generation of wireless mobile technology, 5G.[10] It will be able to carry more data, at higher speeds, potentially 40 times faster than the current 4G.[11]

Download times for various download speeds for a full feature film or a Power Point presentation (estimates for a 1.5 GB movie file and a 25 MB ppt file, source download-time.com)

Download speed	Movie	Power Point
2 Mbps	01:47:22	00:01:44
10 Mbps	00:21:28	00:00:20
24 Mbps	00:08:56	00:00:08
4 G (80 Mbps)	00:02:41	00:00:02
100 Mbps	00:02:08	00:00:02
1 Gigabit	00:00:12	Virtually 00:00:00

What is London's position?

In the UK, the communications regulator, Ofcom, decided in 2005 to encourage service competition on the infrastructure of British Telecom (BT) by creating BT Openreach, a subsidiary that owns pipes and cables connecting to the national broadband and telephone network. Since then, service competition has been promoted by establishing Openreach, by and large as a national infrastructure monopoly. As a result, the UK has benefitted from lower costs and increased competition at service level, but the monopoly model has not seen the corresponding investment in the physical infrastructure.[12]

Against this background, in assessing London's current digital connectivity, there are a number of issues to take into consideration:

- **The lack of an extensive fibre network**

  London does not have extensive full fibre connections. Spain now has 83 per cent of all of its buildings across the country connected to pure fibre. The UK has much less – around 3 per cent or even less – and not in London.[13] The vast majority of the fibre broadband offered by the UK's main service providers in London is Fibre to the Cabinet (FTTC). In this setting, fibre only runs as far as the exchange cabinets in the street and customers have to rely on old copper wiring for the 'last mile'. This

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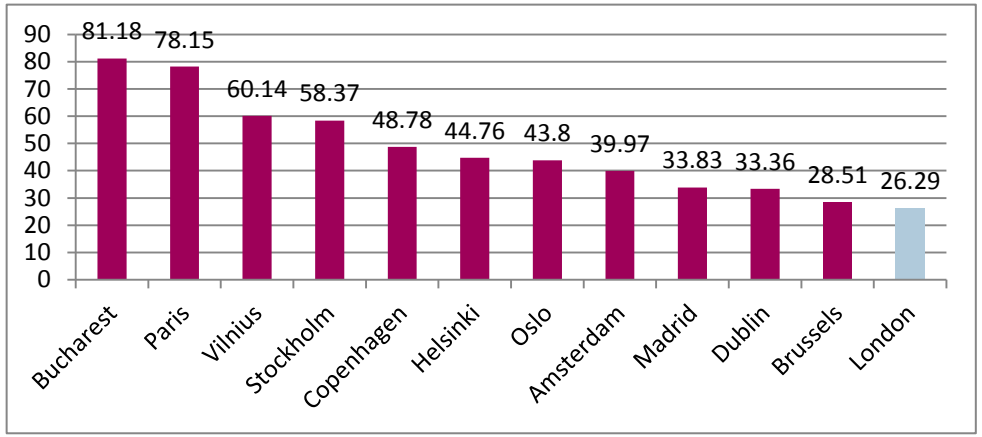
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reduces speed dramatically. Fibre to the Home (FTTH) is needed to bypass the copper problem, with fibre going directly to the premises and providing speeds faster than 1 Gigabit per second.[14] In competitor cities such as Paris or New York, there are fairly substantially large full fibre investment programmes underway in those cities that are not to be seen in London.[15]

- **Poor download (and upload) speeds**

In terms of download and upload speeds, there is little data available to compare London's performance with international competitors. A survey by provider Hyperoptic showed in 2014 that London was ranked 26 out of 33 other European cities in terms of broadband speeds, with an average download speed of 26.3Mbps. Romanian capital Bucharest topped the table with speeds of 81.2Mbps, followed by Paris and Lithuania's capital city Vilnius.[16]

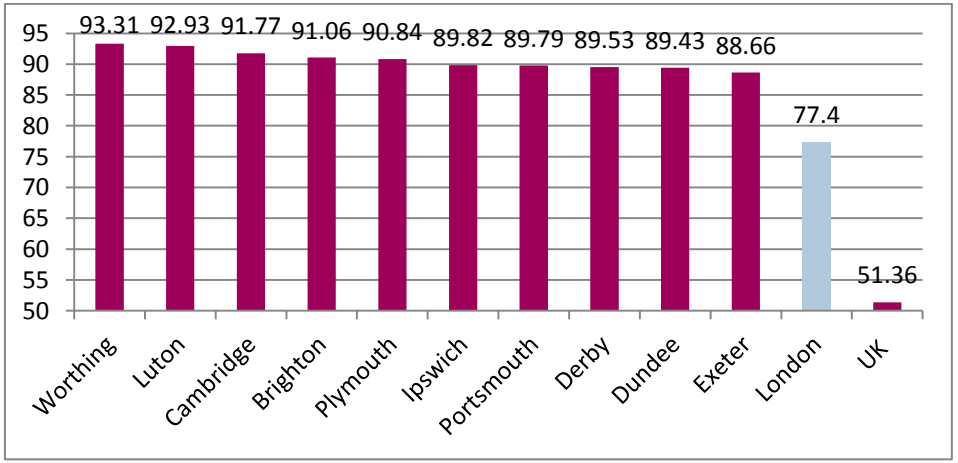
Average broadband speeds in Mbps in European Cities in 2014 (Source: Hyperoptic)



- **Modest coverage of high speed broadband**

Measures have been put in place to improve London's digital connectivity (for example, the 2013 Smart London Plan) and between 2014 and 2016, there has been a slow and gradual improvement in the availability of fast broadband access in London.[17] Still, data from Thinkbroadband collected for 63 UK cities at the end of 2016 show that London ranked 30 with 77.4 per cent of premises covered by ultrafast broadband connections, above the national average of 51.36.[18]

Percentage of premises covered by ultrafast broadband (>100 Mbps) as at end of 2016 (Source: Thinkbroadband.com and Centre for Cities)



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- **Too many 'not-spots'**

  London is also held back by limited mobile 4G coverage. From December 2016 to February 2017, consumer group Which? and analyst OpenSignal measured data from mobile phones across 20 cities in the UK. London ranked in the bottom 5 with 73.6 per cent of 4G coverage.[19] In the capital, areas that have very low or no broadband access and/or mobile connectivity are numerous. These 'not-spots' and 'digital deserts'[20]are usually found in remote corners of rural Britain, but even central locations such as Westminster, the City of London and Southwark are affected, because of the length of copper lines, the street layout or the height of buildings.[21]

- **Unacceptable length of time for setting up a connection**

  While speeds and coverage are below other cities in the UK and worldwide, the problem of connectivity is also related to the time it takes to install a new connection. For example, according to Jonathan Glanz, lead member for broadband and connectivity at Westminster City Council:

  'Residents who come to live in Westminster from other great cities across the world find it absolutely incredible that they cannot do what they can do in Seoul, Singapore, Sydney or New York and just have their connection put in as they move in at a level that will allow them to do everything they need to do.'[22]

BT was recently fined £42 million by regulator Ofcom over delays installing high-speed internet connections.[23] In the UK, between January and March 2017, the average time to install an internet connection was 48 working days for businesses, with about 55 per cent of the connections delivered within 30 working days and 7 per cent within 159 working days.[24]

Digital connectivity – a government priority

Enhancing digital connectivity is a Government priority. In the 2016 Autumn Statement, the Chancellor called for a £1 billion investment in a 'world class digital infrastructure' that would support current and future 'transport, business and lifestyle needs'. The Government is seeking a 'step-change in speed, security and reliability', based on full fibre and an ambition for the UK to be a world leader in 5G. The Government has moved from its strategy of service competition with a monopoly infrastructure provider to a strategy of infrastructure competition. Ofcom has set a target of 40 per cent of premises having access to at least three infrastructure providers.[25]

So far, Broadband Delivery UK (BDUK), part of the Department for Culture, Media and Sport (DCMS), has been implementing the Government's policy on broadband roll-out in three phases:

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- Phase 1, which aimed at providing superfast broadband coverage for 90 per cent of UK premises, is now complete. BDUK developed a delivery framework for use by local bodies to assist in the procurement process, although local bodies could procure outside this framework. The contract was signed by DCMS and BT, which was awarded all 44 Phase 1 contracts.
- Phase 2 started in 2016 and is currently under way, with a target of 95 per cent of premises covered by December 2017.
- Phase 3 will explore options for the hardest to reach parts of the UK. The remaining 5 per cent, about 1.4 million premises, are dispersed across the country but can be found in densely populated areas, including central London.[26]

In London, the previous Mayor addressed connectivity in his 2013 Smart London Plan and set up a Smart London Board of experts to put in place a strategy to make sure digital technology improves for everyone. The aim was also to help make 'superfast broadband available to everyone in London and to invest in digital skills'.[27]

The previous Mayor:

- facilitated the Government's Super Connected Cities vouchers scheme (2013-2015). The scheme enabled small and medium-sized businesses to claim up to £3,000 to cover the cost of superfast broadband
- launched a connectivity rating scheme, delivered by WiredScore, to enable tenants and property brokers to identify spaces which meet their connectivity needs
- created a connectivity map to assist the decision making of digital connectivity providers based on current availability and demand[28]

Altogether, the various programmes so far have used a conventional approach that has not been fully successful. For example, the BDUK programme has tackled easier to reach premises first and has not delivered coverage for particular areas as a whole. Many premises have been counted as covered but they still appear unlikely to receive superfast speeds owing to the poor quality or length of the old copper lines.[29] In places such as Rotherhithe, in Southwark, copper wire still traces older roads it used to take around the dock rather than following the street layout of today. Such a circuitous route bleeds speed since the longer the copper wire, the lower speed and bandwidth at the end of it.[30]

A clear and ambitious vision for the future needs to be put forward. London lags behind York, Coventry and Edinburgh, all 'Gigabit Cities' where download and upload speeds reach 1,000 megabits per second. London should be a Gigabit City.

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What has been done elsewhere through public sector intervention?

There are a number of examples of cities in the UK and worldwide that have benefitted from national or local government intervention to enhance digital connectivity, and they all share common elements, namely dedicated public investment and strong leadership:[31]

- **Strong levels of public investment to upgrade local infrastructure.** In Seoul, a city of comparable size to London, the tech sector has seen government invest £1.1 billion with local firms in a 5G service, with a view to making it commercially available by the end of the decade.[32] In Chattanooga, in the US state of Tennessee, the city government used the city-owned electric utility company to upgrade its infrastructure to a fibre-based 'smart grid'.[33] The network is credited with the creation of thousands of new jobs and the regeneration of the downtown area.[34]

- **City government forging new partnerships to deliver improved connectivity.** The Royal Borough of Greenwich founded Digital Greenwich in 2015 to implement its Smart City Strategy. Digital Greenwich acts as a catalyst on behalf of the borough and includes an innovation centre with office spaces for small and medium-sized digital businesses. With the University of Surrey, they have been developing smart city technologies, with a focus on creating 'resource-efficient, low-carbon, healthy and liveable neighbourhoods'.[35] In Peterborough, the local city council and CityFibre, an internet provider, deployed an ultrafast citywide fibre network which connects public sector sites with gigabit-speed services. The cloud service[36] was then extended to all businesses. The move attracted new SMEs and led to the creation of 7,000 jobs in all sectors over three years.[37]

The Mayor's plans: A new strategy and a Chief Digital Officer

The Mayor has significant influence on the number and location of the new homes and jobs London will need in the future in major regeneration areas across the capital. It is important that he uses this power to address the current barriers to enhanced digital connectivity across the capital. There are numerous opportunities across London, such as the regeneration of Old Oak and Park Royal and London's Opportunity and Intensification areas[38], where digital connectivity can be addressed from the start and at the centre of a smart strategy for development, to ensure they have the most up-to-date standards of connectivity built into the first stages of planning as befits the fourth utility.

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The Mayor has acknowledged the benefits of 'digital connectivity' and 'will do all [he] can to improve digital connectivity in London, establishing it firmly as a key utility central to planning and new development'. The Mayor will also appoint London's first Chief Digital Officer (CDO) to oversee growth in this sector, as well as leading on digital inclusion across the city.[39] The Mayor will create a 'not-spot' team to work with stakeholders 'to address areas where specific improvements are needed'.[40]

The Regeneration Committee welcomes such an ambition and the appointment of a Chief Digital Officer that would lead on issues of connectivity in the capital. But these are early days and the CDO faces a range of challenges.

New York's first Chief Digital Officer, appointed in 2010, began to coordinate activity by creating a Digital Roadmap. The roadmap provided a snapshot of the city's technology efforts and digital achievement to date and chartered a course for realising the city's potential. We support calls for the Mayor to commission a similar review.[41]

We recommend that the CDO adopts the following checklist to help move London towards becoming one of the most digitally connected cities in Europe:

- Tackle digital exclusion with better information and digital skills
- Enable digital connectivity through the London Plan
- Lobby for making existing infrastructure available for fibre
- Tackle 'not-spots' and 'digital deserts'

Tackling digital exclusion: Better information

The CDO must support Londoners to make well-informed decisions with regards to their connectivity needs.

- Little reliable information is available for future tenants, residents and businesses before moving into an area. The committee welcomes initiatives such as WiredScore which have improved the situation. WiredScore informs tech companies and small businesses about the connectivity levels of buildings they are considering occupying before they agree to take out a lease. Through a certification programme called Wired Certification, the team helps landlords to market their buildings as tech-friendly destinations, and businesses can use this information to find buildings that meet their telecommunications needs.[42]

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- Large businesses across London do not seem to suffer from a lack of connectivity as they can afford to privately fund the high cost of fast and reliable connectivity. However, transient and renting tenants have more difficulties accessing faster broadband, since they might not stay in the same place for more than a year or might not be able to commit to a long-term contract. Improving access for these tenants will require putting pressure on providers to offer shorter-term contracts and tailored payment options.

Tackling digital exclusion: Better digital skills

The CDO must also support Londoners, individuals, businesses and charities, to develop and enhance their digital skills.

- In 2016, 6 per cent of London households did not have access to internet; 7.2 per cent of Londoners had never used internet; and 16 per cent did not have basic digital skills.[43] The lack of digital skills holds back economic development: most small businesses that use digital functions (ranging from email to cloud-computing) are twice as likely to report increase in turnover than the 30 per cent of small businesses in London that do not have basic digital skills. At the same time, more digitally mature charities[44] are 28 per cent more likely to report an increase in funding than the 49 per cent of charities than do not have basic digital skills.[45]
- In this regard, although the Mayor has promised that the CDO would prioritise digital inclusion,[46] the committee regrets that, according to the advertised job description, digital inclusion is only a small part of the role's principal accountabilities.[47]
- The committee however welcomes the recently approved pilot project, *Mi Wifi*, at the GLA. The idea is to lend WiFi enabled tablets to specific groups of Londoners, such as older Londoners, disadvantaged Londoners, Londoners with a disability and community groups. The aim of the project is to reduce digital exclusion by empowering community groups and providing them with basic digital skills training.[48] However, without a reliable and cheap internet connection, such a programme will not be of help.

Enabling digital connectivity through the London Plan

The CDO and the GLA must work with boroughs to remove the current administrative and planning barriers to enhanced digital connectivity. These include:

- **Different planning rules across London's boroughs and a costly planning application process.**[49] 85 per cent of the costs of expanding

the broadband network in the capital are so-called 'civil' costs, such as planning regulations and other red tape.[50] For example, stakeholders we met explained how the process of applying for planning applications should be simplified, particularly for listed buildings.[51]

- **Inconsistent wayleave processing across London's boroughs.** To address this barrier, the Mayor and the CDO should go further in the promotion of the City of London Corporation's 'wayleave toolkit' that informs landowners and their legal advisors on what they must do when, for example, they receive a wayleave request (the agreement between the owner and the provider to install a new connection). The toolkit gives broadband providers, SMEs, landlords and developers the documentation they need to deliver digital infrastructure in a fast and effective way. Standardised documents will speed up the installation of broadband for all parties which would also benefit from lower costs and more efficient ways of working.[52]
- **Poor coordination** between providers, local authorities and key property owners. The GLA could start by organising a high level meeting with all stakeholders to meet and exchange best practice.[53]
- **A lack of flexibility.** Broadband cabinets are permitted development[54] and, while they do not require planning permission, telecom operators need to get 'prior approval' from the local authority, which can be refused only on amenity or safety grounds within 56 days of the prior approval application being sought. The CDO should encourage boroughs to be flexible in their approach to prior approval applications, especially in areas where there is evidence of the need for improvement in digital connectivity – where broadband speed is unacceptably slow or where there is the need for more capacity to satisfy local demand for connections.
- **A lack of guidance in the London Plan.** The majority of policies in the London Plan are structured at three levels: strategic statements of Mayoral policy; planning decisions to be applied by the Mayor and planning authorities; and advice to boroughs in preparing their Local Development Frameworks and neighbourhood plans. In the current version of the London Plan, recommendations about digital connectivity have been made only at the first, strategic level. Previous versions of the London Plan have placed more emphasis on action to be taken at borough level to enhance digital connectivity. In his current review of the London Plan, the Mayor should offer stronger guidance to boroughs and encourage boroughs to address connectivity issues in their local development framework. The London Plan should encourage boroughs to produce a local connectivity plan that reflects the actions necessary to ensure there is sufficient access to a minimum level of broadband service. Boroughs should also ensure that any application for new development provides the necessary upgrade to connectivity to meet the level of service specified in the connectivity plan. At the same time, having a digital champion in each borough would be useful to undertake

coordination activities and 'join the dots between the various components of a very complex picture.'[55]

Making existing infrastructure available for fibre

The CDO must encourage bodies such as Transport for London to grant providers access to the ducts they own.

- While Government has made clear that full fibre and 5G are the future, the current wire infrastructure needs significant investment to upgrade it and make superfast broadband a reality. Much of London's critical last-mile infrastructure is copper telephone wire running over long distances directly from the exchange.[56] Premises at the end of the wires often have very poor internet speeds. For a provider, like Community Fibre, the biggest infrastructure cost is related to digging and cabling in order to roll out their fibre network.[57]
- Work needs to be done on the 'backbone' or 'spine' infrastructure, the initial core infrastructure, from which to roll out fibre across the capital. The Government last year placed an obligation on all duct owners to make their infrastructure available to operators and Ofcom published guidance.[58] In a city of the size of London, multiple construction gangs in different parts of the city can be used because they are not going to be tripping up on each other.[59] Providers could use existing networks as opportunities, including the current transport infrastructure owned by Transport for London, to roll out fibre using the 250 miles of Underground network, the 2,300 km of roads or the 6,000 traffic signals throughout the capital.[60]

Tackling 'not-spots' and 'digital deserts'

The CDO must provide leadership to the public and private sectors and initiate partnerships to tackle 'not-spots' and 'digital deserts' across London.

- Because of infrastructure costs, there seems to be little incentive for providers to upgrade connections for small businesses and residents in areas of high commercial density but low residency. Commercial viability is also more challenging for parts of London where residential density is very low. [61] Upgrading the infrastructure also means cabling, digging up roads and pavements which are all costly and cause disruption. In various parts of London, the old infrastructure has not been updated and many areas in the capital are considered to be 'not-spots' or 'digital deserts'. As shown in the City of London and Westminster, leadership and partnership can help solve the issue.
- The City of London Corporation has worked on its own solutions to improve the situation within the Square Mile and to keep on attracting

SMEs after declaring in 2014 that 'Big Telecom' had failed to deliver for its SMEs and residents.[62] The City worked on different solutions, including a free WiFi service. It is currently provided by the Cloud but will be replaced later this year with a new gigabit WiFi mesh network. The £5m investment will be the single largest investment in wireless infrastructure in the City of London. To boost wireless coverage, more than 400 4G small cells will be mounted on street objects such as lamp posts, street signs, buildings and CCTV columns. The third party chosen to manage the assets will start to deploy the cells in 2017 and the rollout will be completed in 2019. The City of London expects that the new service will create attractive market conditions that will make it easier to deploy and adopt 5G technology.[63] Such a decision seems costly, but delivering small cells will bring profits to the City which will be reinvested to fund the gigabit WiFi network. £30 million revenue is expected over the next 15 years.[64]

- Similarly, in 2015, Westminster City Council launched a campaign to improve high-speed broadband in central London by urging BT to step up the pace of installation. According to Ofcom data at the time, less than half of businesses and residential premises in Westminster had access to the BT Openreach fibre network or Virgin fibre broadband.[65] Thanks to this pressure, it was announced at the end of 2015 that BT Openreach would invest significantly in superfast broadband within the area taking the company's total coverage for fibre in the borough to nearly 106,000 premises.[66] The council is also in the process of rolling out a number of high quality, free public WiFi schemes across its estate and is working to improve 4G mobile phone connectivity through the addition of more mobile phone masts and street level micro cells. In addition, Community Fibre has completed deployment of full fibre to the home to Westminster's largest housing estate with over 1,700 properties on the Churchill Estate in Pimlico now having access to gigabit broadband services.

The CDO's Checklist

- **The CDO must support Londoners to make well-informed decisions with regards to their connectivity needs.**
- **The CDO must also support Londoners to develop and enhance their digital skills.**
- **The CDO and the GLA must work with boroughs to remove the current administrative and planning barriers to enhanced digital connectivity.**
- **The CDO must also encourage bodies such as Transport for London to grant providers access to the ducts they own.**
- **The CDO must provide leadership to the public and private sectors and initiate partnerships to tackle 'not-spots' and 'digital deserts' across London.**

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Case Study: How to address the lack of connectivity in Rotherhithe?

Rotherhithe, a residential district in south east London, is a striking illustration of all the barriers identified in this report. Living in this infamous 'not-spot', one of the residents told us that his connection regularly hovers at around 0.26 Mbps.

Access to good broadband has become a significant local issue, as shown in the two maps on the following page. Local residents feel frustrated and excluded, living in central London but having to go to the local library or a café to be able to send emails with attachments.[67] Local residents and businesses have created a pressure group, the Rotherhithe Broadband Group, and have drawn the matter to the attention of the London Borough of Southwark. They have also been lobbying internet service providers for improved services in the area.[68] The group is considering developing its own fibre network based on models of similar groups elsewhere in the UK. A feasibility study was carried out in 2014 and the scheme now needs financing.

Southwark Council has tried to respond to local needs. In 2014, it commissioned engineering consultants Atkins to review broadband access in Rotherhithe. The report identified that poor access in traditional docks areas is not unusual: they have historically been poorly served and the expansion of broadband services has not kept up with the development of homes and businesses in these areas.

The council has brokered a number of meetings with the Rotherhithe Broadband Group, BT, council officers and other stakeholders. Council officers have been working with BT Openreach to encourage them to expand their broadband presence in Rotherhithe and elsewhere in Southwark.

The chosen approach focused on the installation of new cabinets across the borough. In 2015 BT Openreach committed to connect 18,000 premises in the borough. Since April 2016, they have delivered 21 new broadband street cabinets borough wide, providing the opportunity for approximately 6,880 properties to connect to superfast broadband. Nine of those cabinets have been delivered on the Rotherhithe peninsula, representing 2,922 possible new connections.[69]

However, progress is slow and alternative options are needed. Southwark Council met with Oxfordshire County Council to learn from their experience of rolling fibre with BT and BDUK. However, such a programme would not be allowed in London under current state-aid rules. Southwark Council is now setting out a new strategic plan to be published in 2017 and exploring new business models and innovative projects for broadband infrastructure improvements.[70]

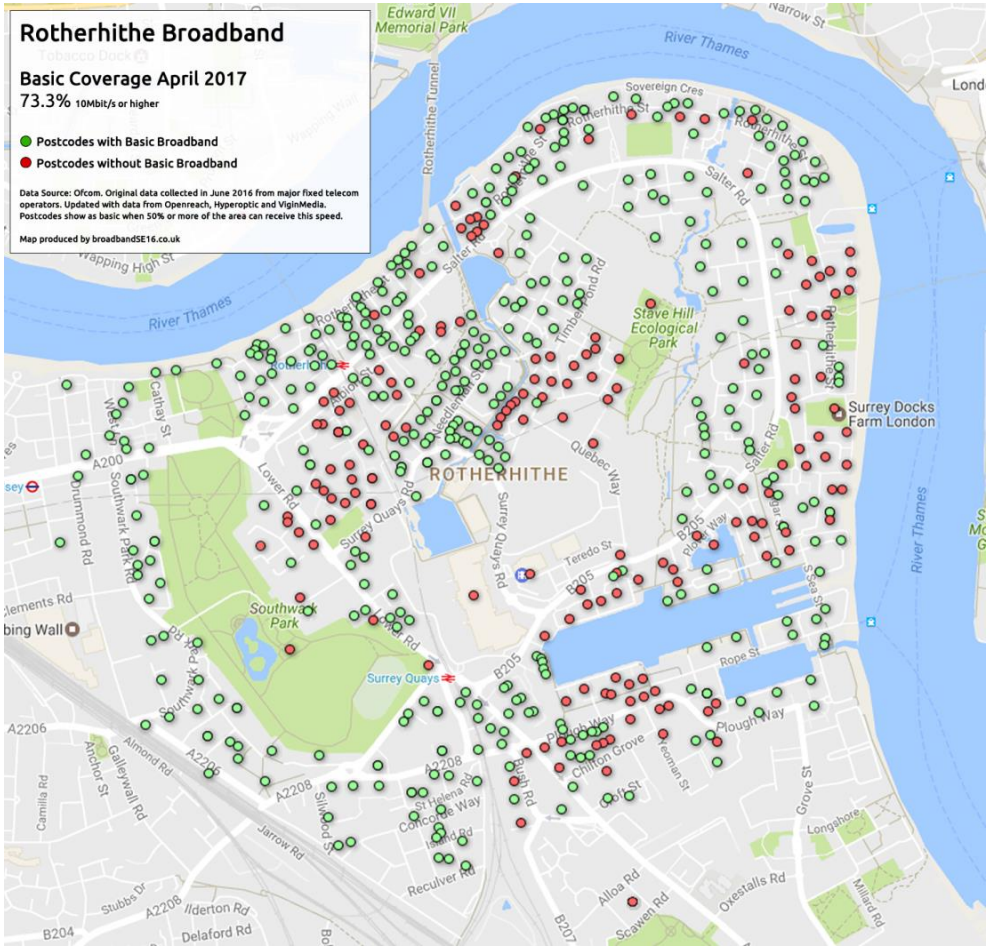
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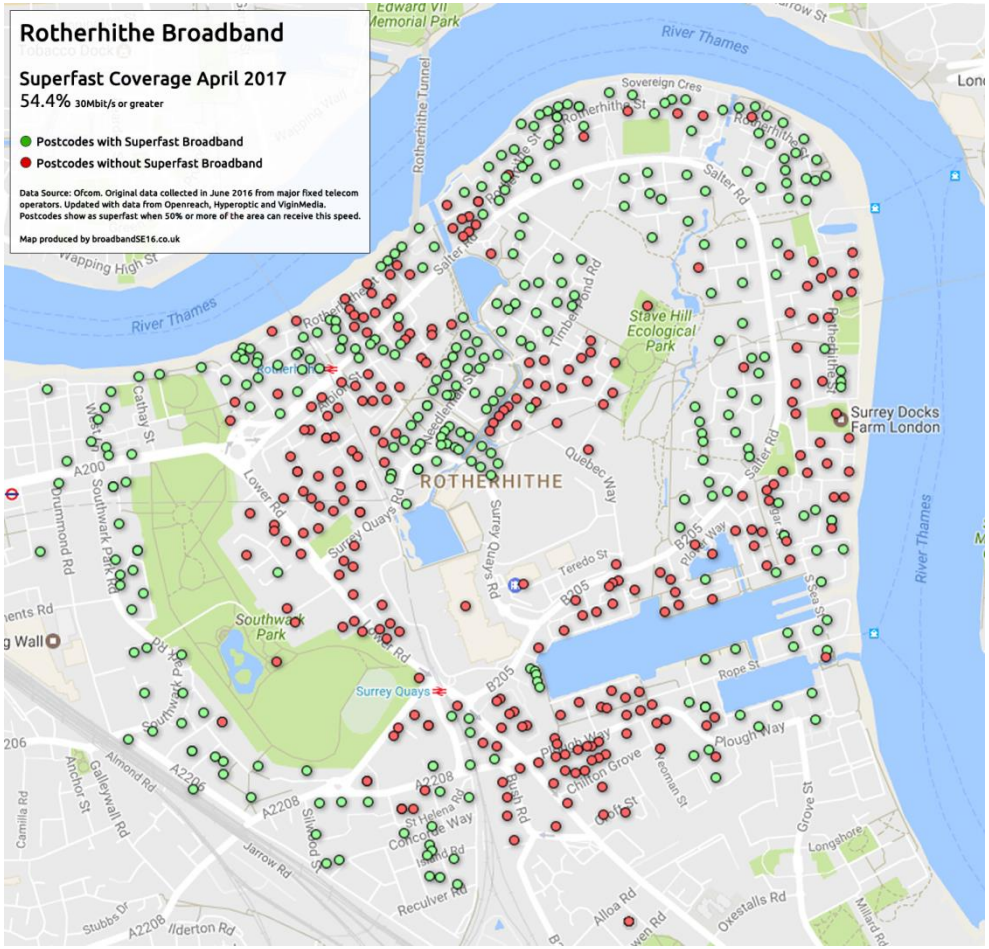
Holding the Mayor to account and investigating issues that matter to Londoners

Regeneration Committee

Digital Connectivity in London

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The committee welcomes the Mayor's intention to establish a 'not-spot team', which will work on a location-by-location basis with all stakeholders. A solution should be found as a matter of priority. The committee heard a call for lobbying Government to change state-aid rule[71] but it seems unlikely to be a Government priority. The Mayor should also look at other solutions, such as supporting the expansion of the City of London's WiFi mesh network, providing a free WiFi service, or an investment in local community schemes.

The example of Rotherhithe shows digital connectivity issues are linked to social exclusion, caused by past investment decisions and programmes that have been market-oriented and have targeted businesses or residents.

The Mayor has planning policies aimed at reducing the inequality and exclusion experienced by sections of Londoners, such as Policy 3.2 in the London Plan on improving health and addressing health inequalities. The policy states that 'boroughs should work with key partners to identify and address significant health issues facing their area and monitor policies and interventions for their impact on reducing health inequalities.' The committee recommends the Mayor uses the London Plan in the same way to encourage boroughs to address digital exclusion.

Endnotes

[1] R Williams, 'Poor broadband hindering London's digital economy', *The Telegraph*, 9 December 2014.
[2] *The fourth utility: Delivering universal broadband connectivity for small businesses across the UK,* Federation of Small Businesses, July 2014.
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[5] S Priestley and C Baker, *Superfast Broadband Coverage in the UK. Briefing Paper*, House of Commons Library, 9 March 2017, p 7 and J Barrow, 'What broadband speed do I need?', Which?.
[6] As shown by the impact of the SuperfastCornwall project on local SMEs. See H Lacohee and A Phippen, *SME Benefits and Business Opportunities with Superfast Broadband: the Virtuous Circle of Connectivity*, September 2013.
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[9] *The fourth utility: Delivering universal broadband connectivity for small businesses across the UK. FSB Discussion Paper*, Federation of Small Businesses, July 2014.
[10] 5th generation mobile networks or 5th generation wireless systems, abbreviated 5G, are the proposed next telecommunications standards beyond the current 4G network.
[11] S Curtis and R Barrat, 'What is 5G? Everything you need to know about the next generation of mobile network technology', *The Mirror*, 8 March 2017.
[12] Mark Collins, Director of Strategy and Public Affairs, CityFibre, speaking to the committee, 1 March 2017.
[13] Ibid.

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[15] Mark Collins, CityFibre, speaking to the committee, 1 March 2017.
[16] R Williams, 'Poor broadband hindering London's digital economy', *The Telegraph*, 9 December 2014.
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[18] Data by *Thinkbroadband.com* published in the Centre for Cities' Cities Data Tool.
[19] 'UK's best and worst cities for 4G mobile coverage revealed', *BBC News*, 3 May 2017.
[20] R Mason, UK 4G coverage worse than in Romania and Peru, watchdog finds, *The Guardian*, 14 December 2016.
[21] *Speedtest Market Report*, Ookla, 15 November 2016.
[22] Councillor Jonathan Glanz, Lead Member for Broadband and Connectivity, Westminster City Council, speaking to the committee, 1 March 2017.
[23] M Sweney, 'BT fined £42m over delays to high-speed cable installation', *The Guardian*, 27 March 2017.
[24] See Openreach performance for January to March 2017.
[25] Tim Stranack, Business Development Director, Community Fibre, speaking to the committee, 28 March 2017.
[26] S Priestley and C Baker, *Superfast Broadband Coverage in the UK. Briefing Paper*, House of Commons Library, 9 March 2017, pp 9 to 14 and 25-26.
[27] *The Future of Smart*, GLA, March 2016.
[28] See the Connectivity Map of London on the GLA website.
[29] S Priestley and C Baker, *Superfast Broadband Coverage in the UK. Briefing Paper*, House of Commons Library, 9 March 2017, p 23 and *Establishing world-class connectivity throughout the UK*, Second Report of Session 2016–17, p 16.
[30] Joining the Dots: Building the Infrastructure for London Tech, Tech London Advocates, April 2015, pp 20-21
[31] Full fibre solutions have also been brought by private investment, as shown by the example of Google Fiber in Kansas City, see P Sisson, 'In Kansas City, Google Fiber has mixed results', *Curbed*, 17 January 2017.
[32] J McCurry, 'South Korean 5G internet move to further increase download speeds', *The Guardian*, 23 January 2014.
[33] Chattanooga Forward, March 2014.
[34] J Koebler, 'The city that was saved by the internet', *Motherboard*, 27 October 2016.
[35] See the website of the 5G Innovation Centre at the University of Surrey.
[36] 'Cloud computing' means storing and accessing data and programs over the Internet instead of a computer's hard drive, see E Griffith, 'What Is Cloud Computing?', *UK PC Mag*, 3 May 2016.
[37] L Evenstad, 'Peterborough launches Digital City programme', *Computer Weekly*, 31 December 2015 and 'Peterborough City Council leader John Holdich: 2,096 new jobs already in 2016', *The Peterborough Telegraph*, 20 August 2016.
[38] Opportunity areas are the capital's major reservoir of brownfield land with significant capacity to accommodate new housing, commercial and other development. Intensification areas are typically built-up areas with good existing or potential public transport accessibility which can support redevelopment at higher densities. They too have significant capacity for new jobs and homes. Together, the opportunity areas have capacity for 575,000 additional jobs and 303,000 additional homes; the intensification areas can accommodate 8,000 new jobs and a further 8,650 homes.
[39] *A City for All Londoners*, GLA, October 2016, p 47.
[40] Sara Kelly, GLA, speaking to the committee, 1 March 2017.
[41] K Hanna and T Scott, *A Chief Digital Officer for All Londoners*, Centre for London, 2016.
[42] See the website of Wiredscore.
[43] Signed decision document ADD2081 *Mi Wifi*, GLA, 27 February 2017 using 2016 data on home internet and social media usage from the Office for National Statistics.
[44] According to Lloyds Bank's UK Business Digital Index 2016, a business or a charity is 'digitally mature' when it is able to manage and store digital information and content;

digitally communicate, interact, collaborate, share and connect with others; digitally purchase and sell goods and services, organise finances, register for and use Government digital services; engage digitally with communities and create basic digital content; increase independence and confidence by solving problems using digital tools and finding solutions. See *UK Business Digital Index 2016. Benchmarking the digital matury of small businesses and charities in the UK*, Lloyds Bank, October 2016, p 10.

[45] *UK Business Digital Index 2016. Benchmarking the digital matury of small businesses and charities in the UK*, Lloyds Bank, October 2016.

[46] Mayor' answer to Question 2017/0663 by Navin Shah, AM, 20 February 2017.

[47] Chief Digital Officer job description as published in May on the website of the Greater London Authority.

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[51] Jeremy Chelot, CEO, and Tim Stranack, Community Fibre, speaking to the committee, 28 March 2017.

[52] This document relates to individual tenant fixed line and wireless (not mobile) telecommunication service connections and does not extend to cover public network infrastructure apparatus. See the website of the City of London Corporation.

[53] Philip Saunders, Parliamentary Affairs Counsel, City of London Corporation, speaking to the committee, 22 February 2017.

[54] Permitted development rights are types of work that can be performed without needing to apply for planning permission. They derive from a general planning permission granted not by the local authority but by Parliament.

[55] Mark Collins, CityFibre, speaking to the committee, 1 March 2017.

[56] *A Mayoral Manifesto for the Digital Economy*, London Assembly Economy Committee, GLA, December 2015.

[57] Jeremy Chelot and Tim Stranack, Community Fibre, speaking to the committee, 28 March 2017.

[58] Guidance under the Communications (Access to Infrastructure) Regulations 2016, Ofcom, 2016.

[59] Mark Collins, CityFibre, speaking to the committee, 1 March 2017.

[60] Tim Stranack, Community Fibre, speaking to the committee, 1 March 2017.

[61] J Sibley, 'Digital connectivity. High-speed internet access is critical for London's businesses and residents', London Councils.

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[65] R Lynch, 'Firms call on BT to speed up London's 'too slow' broadband', *The Evening Standard*, 26 May 2015.

[66] 'BT announces investment to expand fibre broadband rollout in Westminster', Press release – *Mynewsdesk*, 14 October 2015.

[67] Rotherhithe resident speaking to the committee, 22 March 2017.

[68] See the website of the group, Broadband SE16.

[69] Figures for March 2017.

[70] Southwark Councillor Fiona Colley, Cabinet Member for Finance, Modernisation and Performance, speaking to the committee, 22 March 2017.

[71] Ibidem.

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for everyone

Communications Market Report 2019

Publication date: 4 July 2019

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1. Overview

This year marks a significant change in the format of the Communications Market Report (CMR).

The CMR is now an interactive data portal, which allows users to interrogate data collected from industry by Ofcom, data from Ofcom's consumer research, as well as headline figures from selected third parties (including BARB and RAJAR).

Commentary and analysis of much of the data used in the CMR can be found in each of our Media Nations, Online Nation, Connected Nations, and Annual Monitoring Update on the Postal Market reports, where we review and explore specific sectors of the media and communications markets in detail.

In this short document we highlight some key findings revealed by our most recent data.

What we have found – in brief

Internet take-up and smartphone ownership are both unchanged in 2019. Household internet take-up remains at 87%, and 79% of UK adults personally use a smartphone.

Consumers are upgrading to faster broadband. The number of fibre-to-the-cabinet connections overtook standard broadband copper connections for the first time this year, and the number of superfast broadband lines increased by 17% as people upgraded from standard broadband services.

And people are using more data. The volume of data used on fixed and mobile connections both grew by around a quarter, with 240GB being used on average each month per fixed broadband connection and 2.9GB in an average month being used on each mobile data connection.

Much of the growth in data use is driven by online video. Fifty-eight per cent of people watched on-demand video services, up from 53%. This is driven by increased use of subscription video-on-demand services such as Netflix and Amazon Prime Video. There was no change in the proportion of people watching the PSB broadcasters' free catch-up services (BBC iPlayer, ITV Hub, All4 and My5), and for some age groups, this declined.

The total volume of voice calls has fallen, but people are using their mobiles more for calling – and using their landlines less. The volume of minutes originating from fixed-line connections fell again in 2019 (by 17%), while the volume of minutes originating from mobiles went up by 5%. Losses in revenues from fixed voice services contributed to a 4% real-term decline in fixed telecoms revenues year-on-year.

And the volume of traditional text messages continues to fall. More than 5 billion fewer traditional SMS and MMS messages were sent in 2018, as people switched to messaging services such as WhatsApp. This will also have contributed to the increased data volumes on mobile connections.

Revenues stayed the same year on year for the commercial television and radio broadcasters. For commercial TV broadcasters, growth in pay TV and revenue from other sources compensated for a 4% decline in advertising revenue. For the commercial radio sector, losses in local commercial advertising revenue were offset by growth in national advertising revenues, sponsorship and other turnover.

Less was spent on broadcast content in 2018. Spend in the multichannel sector decreased in 2018, and while PSB spend on new UK content was higher than in 2017 due to the football World Cup, spend on new UK content was down by 5% on 2016 (the most recent comparable year due to the cyclical nature of sports events).

2. Key findings

Telecoms

The UK telecoms sector continues to make an important contribution to the overall economy, generating £33.8bn in operator-reported revenue in 2018. UK households spent an average of £83.56 per month on telecoms services during the year, equivalent to 3.3% of average household spend.

There were 26.6 million UK fixed broadband connections at the end of 2018, an increase of 0.5 million (2%) compared to the previous year.

By the end of 2018, there were 15.6 million superfast broadband connections (i.e. lines providing actual speeds of 30Mbit/s or higher), an increase of 2.2 million year on year. The average residential download speed increased by 18% to 54.2Mbit/s in the year to November 2018.

The number of superfast fibre-to-the-cabinet (FTTC) connections overtook the number of ADSL standard broadband connections for the first time during 2018, and superfast connections accounted for 59% of all fixed broadband lines at the end of 2018.

There were 0.5 million full-fibre connections at the end of the year, an increase of 0.2 million compared to 2017. This reflects growing availability of full-fibre services: our Connected Nations Spring 2019 update shows that 7% of UK premises could access full fibre broadband services by January 2019, up from 3% a year previously.

Nearly three-quarters (72%) of mobile connections were 4G at the end of 2018, up from 66% a year previously. EE and Vodafone have already launched commercial UK 5G services, with Three's 5G network due to go live in August 2019 and O2's later in the year.

Average fixed and mobile data consumption increased rapidly in 2018, with average data use per fixed broadband line increasing by 26% to 240GB per month, and average monthly use per mobile data connection increasing by 25% to 2.9GB.

While data consumption grows rapidly, total voice usage continues to decline, and it continues to shift from landlines to mobile: the total volume of outgoing calls from fixed lines fell by 17% in 2018, while mobile-originated call volumes increased by 5%.

Widespread smartphone take-up means that consumers have access to other forms of communication such as email, web-based messaging services (e.g. WhatsApp and Facebook Messenger) and social networking sites. This contributed to a further decline in the use of SMS and MMS messages in 2018, down by 5 billion messages (6%) to 74 billion in 2018.

Pay-monthly continued to be the most common type of mobile subscription in 2018; the proportion of subscriptions that were pay-monthly increased by 2pp to 72%.

The total number of landlines fell by 0.2 million (1%) to 32 million in 2018, as a fall in the number of business lines was partially offset by an increase in residential lines.

Television and audio-visual

Total revenue for the commercial broadcasters in the UK in 2018 was £11.3bn. This was unchanged in real terms since 2018, as increases in pay TV and revenue from other sources (e.g. TV shopping and sponsorship) made up for a 4% decline in net advertising revenue.

The 4% decline in net advertising revenue was less than in the previous year, probably helped by activity around the football World Cup 2018. The decline between 2016 and 2017 was 7.5%.

Spend by the PSBs on first-run UK-originated programming has fallen over time, from a real-terms peak of £3.5bn in 2004 to a low of £2.5bn in 2017. In 2018, PSBs spent £2.6bn on new UK content. Of this, factual content accounted for a fifth of spend, the largest proportion, followed by sport and entertainment.

Total multichannel spend decreased slightly in 2018, to £4.8bn, driven by a 6% decline in spend by the commercial PSBs on their portfolio channels.

News and current affairs still account for the majority of first-run hours on the PSB channels (59%), followed by factual (18%).

For key genres across the multichannel sector, 16% of all hours were first-run, with the majority devoted to entertainment, news and sport. Of the first-run content, 54% was acquired, with the remainder originating either in house (38%) or via commissions (8%). On the PSB channels, 44% of total hours were first-run UK originations.

Lots of people are still watching TV, but they are watching for less time. The average weekly reach for TV was 88.5% in 2018, down from 90.2% the previous year. The amount of time spent watching TV on the TV set is falling faster than reach – the average number of minutes that people in the UK spent watching fell by 11 minutes to 3 hours 12 minutes each day. The PSBs and their portfolio channels accounted for 71% of viewing.

Declines in the amount of time spent watching live TV are more pronounced among younger audiences. Those aged 16-24 spent an average of 1 hour 25 minutes each day watching live TV in 2018, 15 minutes less than in 2017, while 25-34s watched for 2 hours 2 minutes, 18 minutes less than in 2018.

Radio and audio

Commercial radio revenues were flat year on year in real terms in 2018, at £572m. An 11% decline in local advertising was offset by a 5% increase in national advertising, a 7% increase in sponsorship and 18% growth in other relevant turnover (such as revenue from on-air competitions).

Overall reach for radio remained high (89.4%), and the time spent listening has remained the same year on year. Each radio listener spent 20 hours 54 minutes listening to radio in an average week in Q1 2019. Those aged 15-24 spent 12 hours 48 minutes with radio each week in Q1 2019, and although the same as in 2018, this is down from 15 hours in 2015.

Digital share of listening in Q1 2019 increased to 56%, from 51% a year previously. For the national commercial stations, 83% of all listening is through digital platforms. This is up from 62% in 2015,

due to increases in the number of national commercial stations available on digital following the launch of the Sound Digital national multiplex in 2016.

Post

Almost six in ten people (58%) strongly agree that they value the option to be able to use the postal service. However, one-third of people say that they only use post to send greetings cards, and when asked about the services that they use to communicate with friends and family, mobile phone calls, text messages and emails are all considered more important than post.

Just over eight in ten people (84%) send letters or parcels through the post, although the proportion of younger people who send post is lower, at 70%.

3. The interactive data

The Communications Market Report interactive data can be accessed here: https://www.ofcom.org.uk/research-and-data/multi-sector-research/cmr/cmr-2019/interactive

There are four sections in the report: data covering the communications and media sectors as a whole, television and audio visual, radio and audio, and post. This section explains what you can find in each section and sets out when additional data will be added.

Market in context

This section contains data on:

- Advertising spend across the communication and media sectors
- Device and service take-up and use

In August 2019, data will be added detailing:

- Total industry revenues across telecoms, TV, radio and post
- Household spend on telecoms, TV, radio and post

Television and audio-visual content

This section contains data on:

- Commercial TV broadcaster revenues
- Hours and spend on content for commercial TV broadcasters
- Hours and spend for the public service broadcasters, for network and regional services
- TV viewing, including reach, share, and average minutes per day

In August 2019, data on public funding will be included.

Radio and audio content

This section contains data on:

- Commercial radio revenues
- Radio listening, including reach, share, and time spent listening
- DAB digital radio take-up and share
- Community radio revenues and expenditure

In August 2019, data on BBC spend on radio will be included.

Post

This section includes consumer data from our residential postal tracker. In September 2019, data on post volumes and revenues will be added.

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Connected Nations 2020

UK report



Strong, Secure Networks

Published 17 December 2020

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Overview

This is Ofcom's annual Connected Nations report, which measures progress in the availability and capability of broadband and mobile services in the UK. It also highlights the work we are doing, alongside UK and devolved governments and communications companies, to improve these services.

This year's report is being published as the UK continues to address the challenges of the coronavirus (Covid-19) pandemic; a time when people, families and businesses have come to rely on their phone and broadband connections as never before. We report on how the networks have performed during this period and how the availability of services has evolved.

Alongside this, we have published separate reports on broadband and mobile availability in each of the UK's nations. Our interactive dashboard allows people to easily access data for different areas of the UK and specific types of services. We are also releasing the International Broadband Scorecard 2020, which compares the UK's recent position on broadband availability with a number of other European nations.

What we have found:

- **The UK's fixed and mobile networks have generally coped well with increased demands during the pandemic.** A shift to more people being at home drove increased demand on broadband networks during the day, although peak usage remained in the evening. Mobile networks also experienced increases in voice traffic.
- **Gigabit-capable broadband is available to 7.9 million homes (27%).** As well as delivering download speeds of up to 1 Gbit/s, these services offer faster upload speeds and are more reliable than older broadband technologies.
- **Full-fibre broadband is available to 5.1 million homes (18%). This** is 2.1 million more premises (8 % points) than a year ago, and represents the highest year-on-year increase seen so far.
- **Superfast broadband is available to 96% of homes, up from 95% last year.** We now estimate that around 60% of premises that are able to get superfast broadband now take up this service.
- **The universal broadband service is helping some people unable to get decent broadband**. Factoring in coverage from both fixed and fixed-wireless networks, we estimate that around 190,000 homes and businesses (0.6%) are still without access to a decent broadband connection. These properties may be eligible for a connection under the universal service, with no costs to the customer unless these exceed £3,400. We expect around 16,000 properties could receive a universal service connection, without additional costs needing to be met by the customer.

- **The number of mobile base stations providing 5G services has risen ten-fold, to around 3,000 across the UK.** 87% of these are in England, 7% in Scotland and 3% in both Wales and Northern Ireland.
- **Mobile coverage is generally stable.** The four mobile network operators (MNOs) – EE, O2, Three and Vodafone - each estimate they provide outdoor coverage to 98%-99% of premises. Their networks' coverage of the UK landmass ranges from around 79% to around 85%. The Shared Rural Network programme agreed in March 2020 will extend coverage beyond this by 2025.
- **A small, but significant number of properties are still struggling to get connected.** We estimate that 43,000 premises cannot access either a decent fixed broadband service, or good 4G coverage, indoors.

Being connected has never been more important to the UK

People have been relying on phone and broadband services more and more over recent years, and the Covid-19 pandemic during 2020 has brought this reliance into even sharper view. In March 2020, life changed suddenly for millions of people across the UK. Fast, reliable broadband and mobile connections were essential to allow them to work from home, keep up with schoolwork, access medical appointments and public services, stay in touch with friends and family, order shopping online, and keep themselves entertained.

The UK's fixed broadband networks have seen significantly more demand, with average monthly data usage increasing almost 80% in two years. It now stands at 429 GB per connection, up from 315 GB last year (itself up from 241 GB in 2018). As well as an increase in traffic, the Covid-19 lockdown period has also seen a shift in how people use their services. While peak broadband use is still in the evenings and has continued to grow, daytime traffic has increased significantly. Upload traffic has also increased, driven by more use of video calling for work and to keep in touch with friends.

Networks had the capacity to meet these user demands and stayed well within capacity limits. Our research shows average broadband speeds only dipped slightly in March 2020, as much of the nation turned to working, learning and socialising from home.

Mobile networks also successfully coped with the increased demands and changes in network traffic patterns during the lockdown period. There was an increase in call volumes and average call duration when the national lockdown was introduced, which networks successfully handled. As restrictions continued, mobile hotspots shifted away from the city centres to the suburbs and residential areas. Worryingly, 170,000 cumulative hours of service were lost as a result of attacks on mobile base stations - based on false conspiracy theories incorrectly linking 5G to Covid-19 and other health concerns - during this period.

The UK continues to invest in faster, better networks

Gigabit-capable broadband coverage is gathering pace

Coverage of faster, more reliable broadband services is improving across the UK. Gigabit-capable broadband – able to provide speeds of 1 Gbit/s - can be delivered over full fibre networks and the

latest versions of hybrid fibre/coaxial cable networks. Gigabit speeds are now available to 7.9 million (27%) homes. In most UK nations, gigabit-capable coverage is higher in urban areas than in rural ones.

Just over five million (18%) UK homes now have access to full fibre connections – an increase of 8 % points or just over 2 million premises in the past year. This is the largest year-on-year increase in full fibre coverage that we have seen so far. Full fibre and gigabit-capable availability is highest in urban areas in Northern Ireland, and lowest in rural areas of Scotland.

5G services available at around 3,000 sites

EE, O2, Three and Vodafone first started rolling out 5G in the UK last year and have continued to extend their networks across the UK. Many 5G sites are in busy areas and are providing enhanced capacity to existing mobile data services.

Of all 5G sites that have been deployed, 87% are in England, 7% in Scotland and 3% in both Wales and Northern Ireland. This split broadly reflects the national distribution of all mobile traffic across the UK.

Good connections are available to most people across the UK

96% of UK premises have access to a superfast broadband connection with speeds of at least 30Mbit/s. A 30 Mbit/s connection is sufficient to stream a 4K/UHD video or download a one hour long HD TV episode in under 5 minutes, and allows for several devices to work simultaneously. Although most people have superfast broadband available to them, they do not always choose the fastest speeds. We estimate that only around 60% of premises who are able to get superfast broadband actually take it.

Mobile operators provide a high level of 4G coverage outside of premises, with coverage from each mobile network ranging between 98-99% of premises. Indoor 4G coverage ranges between 90% and 95% of all premises. However, coverage levels remain lower in rural areas, and across the extent of the UK landmass. Individual operator coverage ranges between 79% and 85% of all UK geography.

How Ofcom is supporting investment in new networks

Our aim is to support investment in gigabit-capable networks. From April 2021, we will have in place a longer-term regulatory framework for competition and investment for the five years to March 2026, with the aim of supporting investment in full fibre and other gigabit-capable services.

We are also supporting the rollout of new wireless services – including 5G – for people and industry to use. This includes making sure a diverse range of companies can access the spectrum they need to develop innovative new services, bringing a better mobile experience to consumers and delivering economic benefits for the UK.

Ofcom is also working with UK and nations governments to help improve access to mobile and broadband across the UK. Those governments are supporting rollout by investing public money in networks in areas which are unlikely to be covered commercially. We will work closely with the UK Government as it develops plans to invest in full-fibre and gigabit-capable broadband through its UK Gigabit programme. We are also supporting programmes in the nations – Superfast Cymru in Wales,

R100 and the Scottish Broadband Voucher Scheme in Scotland, and Project Stratum in Northern Ireland.

Some people are still struggling to get connected

A small – but significant – number of UK properties still cannot access decent broadband

Around 190,000 premises cannot get a decent broadband service from either fixed or fixed wireless networks. Most of these – 119,000 – are in England; 34,000 are in Scotland, 19,000 are in Northern Ireland, and 18,000 are in Wales.

These premises may be eligible to be connected under the universal broadband service, which came into force in March 2020. This gives homes and businesses the right to request a broadband connection that delivers a speed of at least 10Mbit/s download speed and 1Mbit/s upload speed. Where the costs to provide the connection are below the cost threshold set by Parliament (£3,400), the customer can be provided a service at standard connection and rental charges without having to pay any additional installation charges. Where the cost of connection is above the cost threshold, these premises can still receive a service if the customer pays the additional costs. Around 16,000 premises are likely to fall below the threshold. For many remote premises, costs could be significantly higher, meaning some premises will continue to be without access to a decent service, even with the universal service in place.

So, we will work with the UK Government and industry, to explore technology options and possible ways to fund providing connections to these properties so they do not get left behind.

There are still 4G mobile not-spots

The Shared Rural Network programme agreed in March 2020 will extend 4G coverage, particularly in rural areas, by 2025. Under the agreement, each mobile network operator (MNO) is committed to reaching 88% coverage of UK landmass by 2024, and 90% of landmass within 6 years from 2020 (subject to certain conditions), with an expectation that this will see the 'at least one MNO' footprint (i.e. the area where there is mobile coverage but not necessarily from the same MNO) will reach 95% of UK landmass by 2025. MNOs have now moved into a detailed planning phase and we expect to report on more significant progress as the programme moves into the delivery phase in the year ahead. Other public policy interventions such as the Scottish Government's 4G (SG 4G) Infill programme are also supporting increased rural coverage.

A small number of premises lack decent fixed broadband and 4G

We estimate that around 98% of UK premises can receive both decent fixed and good mobile services, but 43,000 (0.1%) cannot access either.[1] Providing connectivity to these premises is a particular challenge that we will draw to the attention of government and industry when exploring how to connect the most remote premises across the UK.

[1] Premises are considered to have access to a decent fixed connection if the broadband speed is above a download speed of at least 10 Mbit/s and an upload speed of at least 1 Mbit/s and to have access to an indoor 4G mobile service if a connection speed of at least 2 Mbit/s is available.

The UK's networks have generally been resilient, while plans to further increase resilience, and greatly improve security, are underway

The network security incidents reported to Ofcom this year do not show that the pandemic resulted in a noticeable increase in telecoms outages, despite increased demands on the networks. One major incident affecting O2's mobile phone users at the start of the first national lockdown does not appear to have reoccurred. However, it has highlighted some important lessons for the industry about how the latest network technology responded to these unprecedented demand peaks.

The work we started last year with telecoms providers to better understand the most common causes of major outages has identified several themes, and work to tackle them is ongoing.

Ofcom has also been working closely with the Department for Digital, Culture, Media and Sport, and the National Cyber Security Centre, in preparation for the Telecommunications (Security) Bill. The Bill, which has now been introduced into Parliament, will bring new rules and duties for Ofcom on network security.



Fixed broadband and voice

We want everyone to be able to access fast and reliable voice and broadband services, wherever they live and work. These communications services have never been more important than in 2020. The Covid-19 pandemic has highlighted the importance of connectivity for UK consumers as a vital part of how businesses and people communicate and consume information and entertainment.

The steps taken by the UK and devolved governments in response to Covid-19 meant that, during 2020, people relied even more than before on fast, reliable broadband connections in their homes. The networks coped well with the increased demand.

Connectivity in the UK continues to improve, as existing networks are being upgraded and new fixed infrastructure is being built. We support the investment in gigabit-capable and full fibre networks – as do the UK and devolved governments – which give people fast, reliable and future-proofed connections. We report on gigabit-capable coverage for the first time this year.

Most homes and businesses benefit from a choice of broadband connections, which deliver superfast or faster speeds. But there are areas in the UK, and in areas within each nation, where faster services are not available yet. We are concerned about the small number of premises that still do not have access to decent broadband given the importance of connectivity to participating in an increasingly digital society.

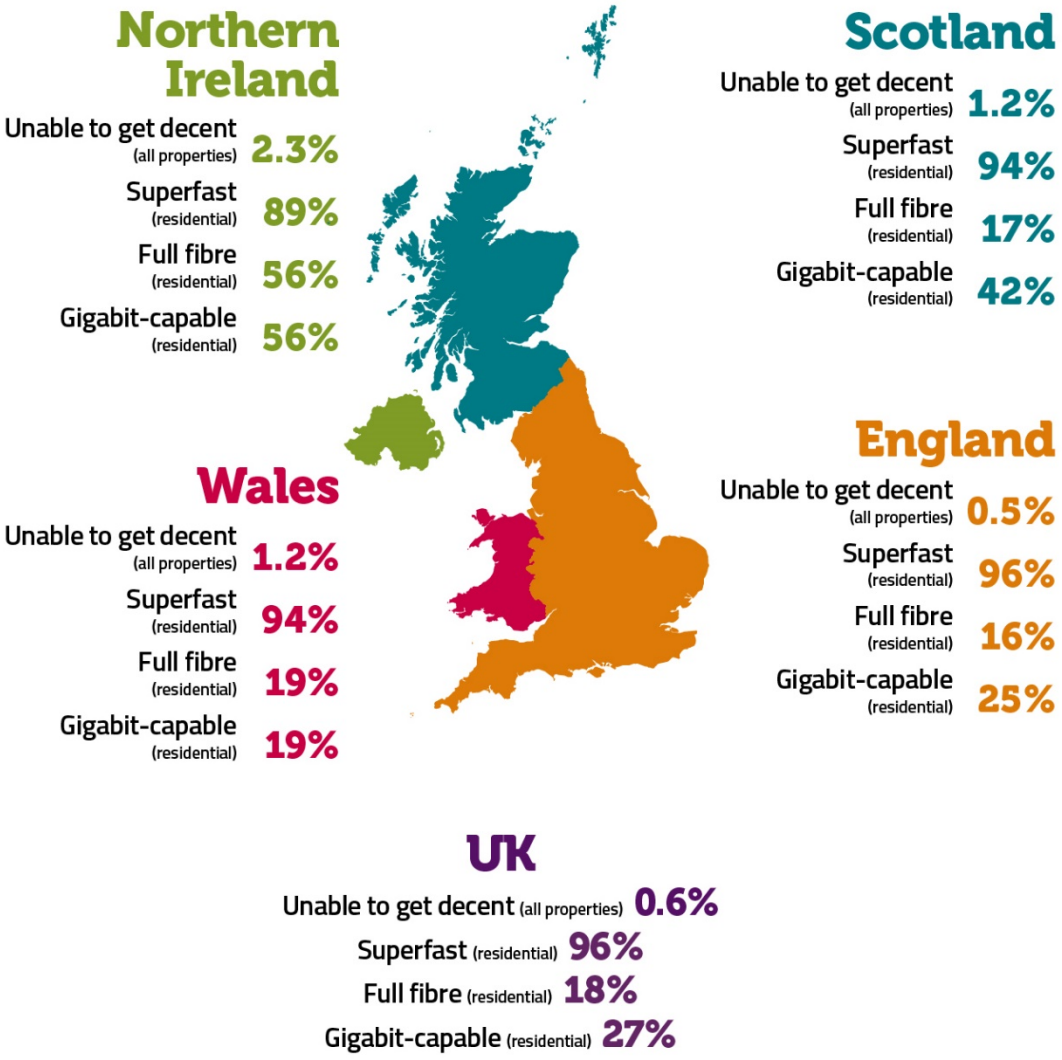
For this report, we have refined our approach to include data from around 20 additional full fibre communications providers and, for reporting on fixed wireless coverage, we have gathered, and include, data from both mobile network operators (MNOs) and a larger number of fixed wireless network operators.

Key highlights:

- **Fixed broadband networks coped well with increased demand during 2020**. While peak data usage continued to occur in the evening, usage during the day and upload usage grew significantly as many people worked from home rather than going into offices and as education moved online.
- **Coverage of faster networks is increasing. Gigabit-capable coverage is at 27% / 7.9m premises. Full fibre coverage is at 18% / 5.1m premises -** an increase of 8 % points /2.1 million premises since our 2019 report. **Superfast coverage has increased to 96%**

- Almost **99.4% of UK premises have access to a decent broadband connection**.[2] Those premises without access to decent broadband remains at around 0.6% / 190,000. The **Broadband USO launched in March 2020** and will provide a connection to some of these premises.
- Average monthly data use has continued to grow, and now stands at **429 GB per connection.**
- **Consumers are upgrading to higher speed packages, but do not always take the fastest packages available to them.** We estimate that around 60% of premises who are able to get superfast broadband actually take a superfast or faster service.

Summary of fixed broadband coverage across the UK and Nations



[2] Unless otherwise specified, coverage figures for decent broadband count all UK premises (residential and commercial). Coverage for all other speed tiers counts residential premises only, unless otherwise specified.

In this section, we report on the following key areas of fixed connectivity:

- the impact that Covid-19 has had on UK fixed networks;
- the rollout and upgrading of networks across the UK (including, for the first time, a summary of investment in fixed networks), as well as the take-up of services on these different networks;[3]
- progress of the broadband USO, which launched in March 2020; and
- progress in replacing the UK's public switched telephone network.

The UK's fixed access networks have been able to meet increasing user demand during Covid-19

Data usage during Covid-19

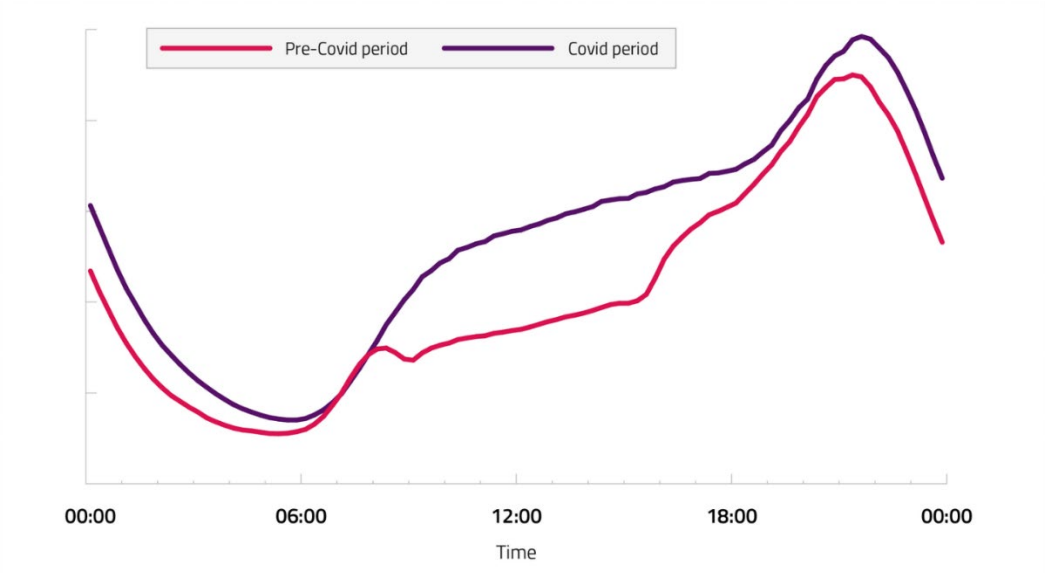
During 2020, the UK's fixed access networks have seen significantly increased demand from users. The nationwide lockdown, and subsequent restrictions, due to the Covid-19 pandemic saw many more people using their home broadband connections for work, for keeping in touch with friends and family, for accessing essential services, and for leisure. Networks generally had the capacity to meet user demands.

To understand how traffic on fixed broadband networks from residential and business customers changed during this time, we gathered data from a range of communications providers. We requested data spanning the period from February to July 2020 to capture the period immediately before and immediately after the first national lockdown, and the period as these restrictions were lifted. In addition to traffic volumes, we also asked for any analysis of the main applications driving any change in traffic levels or distribution.

Some communications providers were able to provide detailed reports covering the entire period, whereas others had higher level analysis, or data for only part of the requested period. Figures 1 and 2 show the typical traffic profile for weekdays and weekends before and after lockdown was imposed in mid-March.

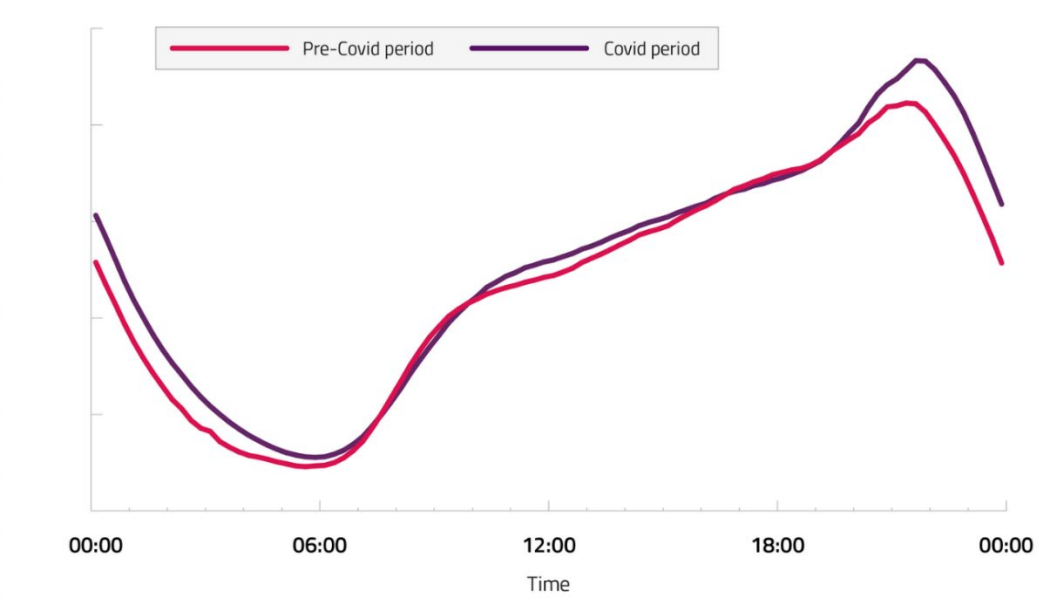
[3] Coverage data in this report is from September 2020; further deployments have been made since then.

Figure 1: Average traffic profile (Gbit/s) on weekdays before national lockdown (27 Jan to 22 March) and during national lockdown and subsequent restrictions (23 Mar to end July)



Source: Ofcom analysis of provider data.

Figure 2: Average traffic profile (Gbit/s) on weekends before national lockdown (27 Jan to 22 March) and during national lockdown and subsequent restrictions (23 Mar to end July)



Source: Ofcom analysis of provider data.

The charts show that:

- **Peak traffic was in the evening**: The peak of downstream traffic continued to be in the evening.
- **There was a significant increase in traffic during the day**: the shift to people being at home during the day, home working and home schooling drove significant increases in daytime traffic.

- **There were significant increases in upstream traffic:** Whilst this was true for both the daytime and in the evening, daytime increases were most significant. In some cases this meant the peak time for upstream data use shifted to during the day. This is consistent with the shift to home working and the use of business services from home, such as video conferencing. One provider suggested traffic spikes at the start of each hour were related to the use of video conferencing using applications such as Microsoft Teams.
- **Weekend traffic remained more consistent in pre- and post-lockdown periods:** There was less difference in traffic profiles at the weekend compared to during the week. This aligns with the largest shift in traffic being driven by home working and home schooling.
- **There were a number of large traffic spikes:** Traffic spikes were seen through the period, sometimes coinciding with the evening peak but also during the day. These were generally attributed to gaming downloads when new games or updates were released. Gaming downloads which coincide with the evening peak have been attributed with producing the highest loads on networks even prior to the pandemic and continue to be a major driver of unusually high traffic loads.[4]
- **ISPs, content providers and Ofcom worked together to effectively manage demand:** At the start of the lockdown period, major streaming sites including Netflix, YouTube, Amazon Prime and Disney+ (which launched around the start of lockdown in the UK) took action to reduce the streaming rates of their services. These controls were slowly lifted during the lockdown period as traffic on the networks became stable and ISPs were confident in the capacity available to carry streaming traffic with higher definition. In addition, we worked with the gaming industry, the Content Delivery Networks (CDNs) that distribute gaming downloads and the major ISPs to manage games releases so as not to adversely impact network congestion.

Overall the networks coped well. For major networks, peak traffic increased during the early phase of the first lockdown in late March and April. However, this generally remained below the spikes in peak traffic seen immediately prior to lockdown when major gaming releases coincided with the peak times. After this initial increase, peak traffic remained largely constant on average, meaning traffic levels remained higher than prior to lockdown, though this varied across different networks.

Providers plan their networks to have spare capacity to cope with year on year traffic growth and spikes associated with especially busy events. This has provided sufficient headroom to cope with any increased peak demand during the pandemic.

Impact of Covid-19 on availability of services

Telecoms engineers were designated as key workers so were able to continue building networks during the lockdown and during the restrictions that followed. As we report below, coverage of fixed networks has improved since last year. However, different approaches in different regions of the UK meant that new network build, and provisioning new connections, were impacted in some areas more than others.

[4] See for example, ISPreview, Broadband ISP TalkTalk Breaks Own UK Internet Traffic Record, 15 November 2020 and ISP Review, Openreach Reports High UK Data Traffic on PS5 Launch Day, 20 November 2020

Like other businesses and organisations, restrictions as a result of Covid-19 meant that communications providers needed to change their own working patterns and priorities. On 24 March 2020, in response to restrictions on its engineering workforce, Openreach declared 'Matters Beyond Our Reasonable Control' (MBORC), which meant taking action to prioritise only essential work and minimise work that required engineers to enter customers' homes.[5] Whilst Openreach engineers continued to provide essential in-home services to vulnerable customers, to ensure they stayed connected, this declaration of MBORC particularly impacted the provision of new full fibre connections on Openreach's network, which require engineers to enter the customer's premises.

This did not have as much of an impact on customers switching between retail providers on the Openreach network, or upgrading between services provided on Openreach's fibre to the cabinet (FTTC) network as these typically do not need an engineer visit.

Again, in common with other businesses, retail communications providers needed to rapidly shift their working patterns. Many staff moved to remote working. Call centres came under increasing pressure as customers sought to ensure they had fixed broadband connectivity. Some communications providers who use overseas call centres based in countries with strict Covid-19 restrictions found their capacity came under particular pressure.

Impact on customer demand

Despite the pandemic, providers have not reported a clear or consistent pattern of increased demand from customers seeking faster or more reliable broadband connections. Analysis of provider data shows that some providers saw increased demand from their customers for faster connections, while others did not observe such demand changes (and others did not specifically track this). One provider offering full fibre services saw a small shift in demand towards slower (but still at least superfast) speeds, perhaps reflecting increased price sensitivity.

Constraints on sales capacity (in-store and call centres) may have meant that consumers wanting to request faster broadband were unable to do so.

Full fibre connections typically require an engineer to enter a customer's home, which was restricted during the initial UK-wide Covid-19 lockdown. Customer demand for these connections – whether from customers seeking a new connection, or from existing customers seeking to upgrade their services – may not have been possible to fulfil during the period in which in-home visits were significantly restricted.

We report on take-up of different services later in this section.

[5] See for example ISP Review, COVID-19 – Openreach Limit UK Broadband ISP and Phone Work UPDATE, 24 March 2020

A variety of fixed broadband networks and services are available in the UK

Fixed broadband in the UK is available at a variety of speeds, delivered over different technologies

Different technologies used to deliver fixed broadband connections

- **Copper (ADSL) -** Copper from the exchange to the premises (also known as 'standard broadband'). Maximum download speed is up to 24 Mbit/s. Actual speeds delivered by copper connections diminish with distance. Copper can also be affected by weather. Since the copper network is old, it can be susceptible to faults. [6]

- **Fibre to the cabinet (FTTC)** - Fibre to the cabinet, with copper used to connect from the cabinet to the premises. Maximum download speed is up to 80 Mbit/s (except for G.fast). [7] As with ADSL, actual speeds diminish with distance, and the network can be affected by weather and is susceptible to faults.

- **Hybrid fibre coaxial cable (HFC)** – The cable TV network. [8] It uses fibre to a street cabinet and coaxial cable from the street cabinet to the premises. There is decreased signal loss which means co-axial cables are capable of delivering much higher speeds than copper wires. Broadband is supported using the DOCSIS standard, which shares the capacity downstream and upstream between multiple customers. [9] The latest standard of cable technology, DOCSIS 3.1, is capable of delivering download speeds of up to 10Gbit/s and upload speeds of up to 1Gbit/s, although in practice speeds average out significantly below this – and since capacity is shared among users, it may not be the case that each user can simultaneously receive gigabit speeds. Depending on the configuration of the access network in any particular area, this can lead to localised congestion. This may be particularly acute in the upstream direction where total capacity is more limited.

- **Full fibre or 'fibre to the premises' (FTTP) –** The connection from the exchange to the premises is provided entirely over optical fibre. Generally, distance to the premises does not affect the speed delivered. Full fibre is less susceptible to faults and is not usually impacted by weather. Most full fibre implementations utilise Passive Optical Network (PON) approaches where capacity in the downstream and upstream direction is shared. [10] Congestion can more easily be avoided on this shared network by limiting the number of customers connected to each shared PON and by managing the maximum guaranteed throughput provided to each customer. PON technology has an upgrade path that allows for speed to increase from a shared 2.5 Gbit/s down/1 Gbit/s up to

[6] ADSL: Asymmetric Digital Subscriber Line.
[7] Openreach deploys G.fast at some cabinets. It uses fibre to the cabinet, and copper from the cabinet to the customer. By using a higher frequency signal on the connection to the customer, G.fast can offer higher speeds than normal FTTC deployment, with Openreach offering wholesale services at up to 330 Mbit/s. But the signal degrades more quickly so the customers able to get ultrafast speeds are limited to those closest to the cabinet.
[8] Most cable broadband in the UK is provided by Virgin Media.
[9] DOCSIS: Data Over Cable Service Interface Specification.
[10] Virgin Media is also deploying some full fibre networks as part of its network expansion. Currently this uses a technology called Radio Frequency Over Glass (RFOG) which allows the DOCSIS signals to be carried over fibre end to end. This deployment is capable of also supporting PON technologies.

10 Gbit/s in both directions, and future generations will expand this further. This allows for services offering 1 Gbit/s both download and upload, with customers choosing a speed package to suit them.

Figure 3.1: Summary of characteristics of different types of broadband

Type of broadband	Speed	Use cases
Decent[11]	10 Mbit/s download; 1 Mbit/s upload	Making a high definition video call using applications like Zoom, Teams, WhatsApp or Facetime. Download a 1 hour HD TV episode (1GB) in almost a quarter of an hour.
Superfast	At least 30 Mbit/s download, up to 300 Mbit/s	One person streaming 4K/UHD video; downloading 1 hour HD TV episode in under 4 and half minutes. Several devices working simultaneously.
Ultrafast	At least 300 Mbit/s download, up to 1 Gbit/s	Multiple people streaming UHD video; downloading a 1 hour HD TV episode in under 30 seconds. Improved upload speeds better for internet gaming and video conferencing.
Gigabit	1 Gbit/s and above download	Provides quicker downloading than most ultrafast packages (and may offer greater upload speeds). Can download a full 4K film (100GB) in under 15mins. May be delivered over technologies that give greater reliability and that are future proofed as more high demand services are developed.

Figure 3.2: Technologies that can deliver different types of broadband

Type of broadband	Copper (ADSL)	Fibre to the Cabinet	Hybrid fibre coaxial cable	Fibre to the Premises
Decent	Yes	Yes	Yes	Yes
Superfast	No	Yes	Yes	Yes
Ultrafast	No	No[12]	Yes - DOCSIS3.0 can provide ultrafast speeds.	Yes
Gigabit	No	No	Yes - Cable that has been upgraded to DOCSIS 3.1 can deliver gigabit speeds.	Yes

[11] The UK government defines a decent broadband service as one that delivers at least 10 Mbit/s download speed and 1 Mbit/s upload speed. This is the level of connection deemed necessary for consumers to participate in a digital society.
[12] See footnote 7.

Broadband to fixed locations can also be delivered wirelessly, providing an alternative to wired connections

Some premises may be served by broadband provided over a wireless network (known as fixed wireless access, or FWA), using either a mobile network or a dedicated network. As the capacity in the wireless access network is shared between multiple users, the service needs to be managed appropriately to meet user demand, particularly in areas with capacity constraints. As coverage predications are based on predictive modelling tools, localised issues may mean that particular premises may not be able to receive a service despite being predicted to do so.

Fixed wireless access on mobile networks is offered on licensed 4G and 5G networks, usually to an indoor router. These services share the network capacity with mobile users, meaning that the capacity of the network has to be carefully managed between the demands of existing mobile users and FWA customers. There may be areas of high mobile demand where a reliable FWA service cannot be offered.

Broadband services to a fixed location are also provided by Wireless Internet Service Providers (WISPs). The majority of these services are delivered over wireless networks that communicate via a wireless link between a provider's mast site and an external antenna fixed to a customer's premise. These networks generally use license exempt or light licensed spectrum. Due to the frequencies where this spectrum is available, performance may be limited by line of sight issues.

Fixed broadband coverage has continued to increase across the UK

Gigabit-capable broadband is now available to 27% premises, including 18% full fibre connections

Full fibre (FTTP) broadband is now available at 18% / 5.1m premises

Our data shows that 18% / 5.1m residential premises in the UK are now served by full fibre connections – an increase of 8 percentage points, representing over 2 million premises in the past year. This increase is largely due to the continued investment in the rollout of fibre networks in the UK from providers included last year, such as BT, CityFibre and KCOM. However, we are now including coverage data from many more, predominantly smaller, fibre network providers. Whilst these providers do not significantly alter the national figures, they are important in providing full fibre coverage at the local level.

Gigabit-capable broadband is now available at 27% / 7.9m premises

We are reporting on gigabit capable broadband for the first time in this report. The UK Government has set a target of at least 85% gigabit coverage by 2025, alongside an ambition to get as close to 100% as possible.

When all technologies are combined, our data shows that 27% / 7.9m residential premises now have access to gigabit-capable broadband. Some of these premises have access to more than one gigabit-capable network: 2% / 615,000 residential premises have access to a gigabit-capable broadband service over both cable and full fibre technology, and 1% / 335,000 have a choice of two full fibre networks.

Figure 4: Residential gigabit-capable and full fibre coverage

	Full fibre	Urban	Rural	Gigabit-capable	Urban	Rural
England	16%	16%	17%	25%	26%	18%
Northern Ireland	56%	71%	17%	56%	71%	17%
Scotland	17%	18%	12%	42%	47%	13%
Wales	19%	19%	19%	19%	19%	19%
UK	18%	18%	17%	27%	29%	17%

Source: Ofcom analysis of provider data.

In Wales and Northern Ireland, all gigabit-capable services that were live at the time of collecting this data used full fibre as their underlying technology, which means coverage was the same for both. In November 2020, Virgin Media announced that it had made gigabit-capable cable services available across its network in Northern Ireland.[13] This will be reflected in future updates next year.

Rollout of full fibre and gigabit-capable networks

Full fibre and gigabit-capable networks are still at a relatively early stage of rollout. Different providers are taking different approaches to their business models for deploying these networks:

- Openreach is the incumbent wholesale infrastructure provider for almost all of the UK.[14] It has the largest network and connects the most premises. It has plans to reach 20 million premises with full fibre by 'the mid-to-late-2020s', 'including a significant build in rural areas.'[15] This includes 3.2 million homes in harder to reach areas by 2025/26.
- Virgin Media has targeted bringing 'gigabit speeds' to close to 15 million premises by the end of 2021.[16] Between the time of data collection for this year's report (September 2020) and the time of writing, Virgin Media has enabled further areas with gigabit capable services.[17]
- Some providers, like Hyperoptic and Community Fibre, focus on connecting premises in urban areas. Hyperoptic is pursuing a target of rolling out its full fibre network to 2 million premises (both residential and business) by 2021 and 5 million by 2024.[18] Community Fibre aims to roll out full fibre broadband to 1 million London premises by 2023.[19]

[13] Virgin Media, Virgin Media brings gigabit broadband to its entire Northern Ireland network, 5 November 2020

[14] KCOM is the incumbent in and around the city of Kingston upon Hull. They committed to a full fibre deployment a number of years ago and availability is approaching 100%. KCOM are planning to extend their full fibre footprint beyond their traditional area of operation.

[15] BT Group, Financial results: Results for the full year to 30 June 2020, 31 July 2020

[16] Virgin Media, Virgin Media to bring next-generation gigabit internet to millions of homes across the UK, 25 July 2019

[17] Virgin Media, Virgin Media brings gigabit broadband to its entire Northern Ireland network, 5 November 2020

[18] Hyperoptic, Gigabit broadband designed for new build homes

[19] Community Fibre, Community Fibre to invest up to £400 million in accelerated expansion of full fibre broadband to one million households and businesses across London, 29 July 2020

- CityFibre plans to pass 'up to 8 million premises' (both residential and business) across 62 towns and cities.[20] It frames its ambitions in light of the UK Government's target for gigabit-capable coverage (which is now for a minimum of 85% of UK premises by 2025, with an ambition to get as close to 100% as possible).
- Providers like Gigaclear, B4RN and a number of others focus on connecting more rural areas. There are a range of approaches taken by these providers. Some work closely with local communities to determine areas with demand, and may include the local community undertaking some of the work. Others plan their own commercial builds in areas they assess as less well served by providers such as Openreach. Some may also bid for public funding to support rollout. A provider may follow one of these approaches, or a combination of them.

Deploying these new networks requires significant investment and engineering resources. The cost and timeframes for deployment can be reduced if a provider can roll out its network by using Openreach's ducts and poles. Openreach has c.460,000km of duct and c. 4,000,000 poles. Regulation to allow this access has been in place since 2010, but changes to our regulation in 2019 were designed to allow easier access to Openreach's physical infrastructure (PIA).[21] As at the end of September 2020, 95 providers had registered with Openreach as customers of PIA, and approximately two-thirds have already built network using PIA or had placed orders to do so. Providers had ordered c.17,000km of duct and c.90,000 poles to deploy networks. Our Wholesale Fixed Telecoms Market Review is considering the rules we should put in place to support investment in networks, including around access to physical infrastructure, and we will publish our final statement by end of March 2021.

Also, the UK Government is working with industry and other stakeholders to ensure that the process for installing full fibre in new-build and multi-dwelling units is simplified, including reducing the administrative burden required for accessing wayleaves.

While rollout of new networks has progressed since our last report, as set out above, there were constraints during Covid-19 on the capacity of network builders to carry out this engineering, and on the potential for engineers to enter buildings and homes to complete the fibre build. This is likely to have impacted the rate of fibre build in the period in which the most stringent lockdown measures were in place.

UK customers can increasingly choose ultrafast connections

59% / 17.2m UK residential premises can now choose an ultrafast connection – an increase of 6% / 1.8m since 2019.

The increased coverage of ultrafast broadband has been driven by the roll-out of full fibre and gigabit capable networks as set out in the previous section, as well as Openreach's deployment of G.fast. Openreach has now paused its G.fast deployments as it focuses on full fibre build.[22]

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[20] CityFibre, CityFibre reveals 36 more towns and cities to benefit from full fibre as rollout accelerates, 6 March 2020

[21] Ofcom, Review of the wholesale local access market, 7 October 2010
Ofcom, Promoting competition and investment in fibre networks – review of the physical infrastructure and business connectivity markets, Volume 1, 28 June 2019

[22] ISP Review, Openreach Confirm G.fast Broadband Rollout Paused Until 2021 UPDATE, 24 June 2020

Most homes in the UK have access to at least a superfast broadband connection

Rollout of superfast networks has been underway for many years, so coverage was already high (95%) in 2019. This year's report shows that superfast broadband is now available to 96% / 27.8m of UK premises, an increase of 450,000 over the year.

Figure 5: Residential superfast coverage

	Superfast	Urban	Rural
England	96%	98%	84%
Northern Ireland	89%	99%	66%
Scotland	94%	98%	72%
Wales	94%	98%	78%
UK	96%	98%	81%

Source: Ofcom analysis of provider data.

Investment in superfast broadband networks will continue in the future. This is likely to be predominantly due to publicly funded rollout under a number of schemes (described below). However, investment in the coming years is likely to be in gigabit capable networks. While superfast broadband is generally sufficient for lots of today's user needs, as demand for higher speed and better networks increases, gigabit capable networks will become increasingly important.

Decent broadband over a fixed connection is available to almost all homes and businesses

Taking into account all fixed line connections, 98% of UK homes and businesses have access to at least decent broadband, the same percentage as in 2019. Around 583,000 premises do not have access to decent broadband via a fixed connection.

Figure 6: Premises unable to receive decent broadband from a fixed line

	Total	Rural	Urban
England	1% (387,000)	7% (240,000)	1% (146,000)
Northern Ireland	6% (49,000)	19% (43,000)	1% (6,000)
Scotland	3% (95,000)	17% (85,000)	<1% (10,000)
Wales	3% (52,000)	13% (45,000)	1% (8,000)
UK	2% (583,000)	10% (413,000)	1% (170,000)

Source: Ofcom analysis of operator data.

Broadband delivered wirelessly to fixed locations can meet the needs of some people, including those in areas without access to decent broadband over wired connections

Fixed Wireless Access on mobile networks

Of the four MNOs in the UK, only O2 does not currently offer FWA services. For areas with poor indoor coverage, EE offers an external antenna for its FWA services.

Based on the MNOs' claimed coverage, we estimate that 95% of UK premises have access to an MNO FWA service. EE claims an average download speed of 31Mbit/s for customers on its 4G FWA service and 150Mbit/s on its 5G FWA service. [23, 24] Vodafone claims to have made its FWA product available at all properties where a mobile signal is available.[25] However, as we explain above, the end users' experience of the service could be affected by where they place the router, their indoor mobile coverage and the capacity available in the wireless access network and in the backhaul.[26]

Based on the data provided by the MNOs, currently 92% of FWA customers have access to a 4G FWA device compared to 8% who have access to a 5G FWA router.[27]

Fixed wireless access from WISPs

For this year's report, we have taken a new approach to collecting WISP coverage data, asking operators to provide their own estimate of coverage, factoring in network capacity constraints, interference and other external factors.[28] Based on providers' estimates, around 1.4m homes and businesses have coverage from a WISP network.

There are many more WISPs who have not given us their coverage data, so coverage from these providers could be higher. We intend to continue to collate and analyse data from these providers and monitor changes to the sector.[29]

[23] EE, 4GEE Home Router 2, [accessed 23 November 2020]
[24] EE, Pay Monthly Mobile Broadband Devices, [accessed 23 November 2020]
[25] Although we do not have data on what performance can be delivered on their network.
[26] Backhaul here refers to the bandwidth available between the cell site and the mobile network core.
[27] Consumers with a 5G FWA device but who cannot receive a 5G signal would be served by a 4G network where there is coverage.
[28] Ofcom, Technical Guidance for WISPs, 28 September 2020
[29] If WISPs would like to provide information as per the technical guidance, they can get in touch via the mailbox connectednationsreport@ofcom.org.uk.

Figure 7: Coverage of MNO and WISP FWA networks

	MNO FWA	WISP FWA
England	95%	3%
Northern Ireland	83%	3%
Scotland	94%	1%
Wales	91%	33%
UK	95%	5%

Source: Ofcom analysis of provider data.

FWA and the impact on the availability of decent broadband

If the networks are managed well, both MNOs and WISPs can deliver a decent broadband service and are an alternative network technology for consumers who cannot receive a decent broadband connection from their fixed network.

Based on the coverage estimates provided by FWA providers, we estimate that 393,000 premises that do not have access to a decent broadband service from a fixed network could have access via an FWA network. This provides an additional 1.3% of decent broadband service coverage to the UK. This breaks down into 51,000 premises that have access from a WISP network, and 342,000 premises that have access from an MNO FWA service. Some premises that can get decent broadband on a WISP network may also be covered by an MNO FWA service. Over the next year, we plan to work with FWA providers to understand how they manage the capacity of their network to ensure that a reliable service can be provided to their customers.

Figure 8: Access to a decent broadband service by different types of technology

	Has no access to decent broadband from a fixed network	Has access to decent broadband from an FWA network	Remaining premises without access to decent broadband
England	387,000	268,000	119,000
Northern Ireland	49,000	30,000	19,000
Scotland	95,000	60,000	34,000
Wales	52,000	35,000	18,000
UK	583,000	393,000	190,000

Source: Ofcom analysis of operator data.

A small – but nevertheless important – subset of UK premises still cannot access decent broadband

Our latest estimate is that 0.6% / 190,000 premises in the UK still do not have access to a decent broadband service via either a fixed or fixed wireless network. This figure has stayed consistent with our estimate of 189,000 last year.[30]

These premises may be able to have a new connection built under the broadband Universal Service Obligation (USO). We estimate that of the 190,000 premises, there are around 7,000 premises that are due to receive a decent broadband service under a publicly funded scheme within the next 12 months (these schemes are set out below). These premises are not eligible for the USO under the terms of the USO Order.[31]

The Broadband Universal Service Obligation (USO)

The broadband USO provides everybody with the right to request a broadband connection with the following technical characteristics:

- a download sync speed of at least 10 Mbit/s;
- an upload sync speed of at least 1 Mbit/s;
- a contention ratio of no more than 50:1;
- latency which is capable of allowing the end user to make and receive voice calls effectively; and
- the capability to allow data usage of at least 100GB per month.

Where an affordable service with the above characteristics is not available, or due to be available in twelve months under a publicly funded scheme, the customer is eligible for the USO if the costs of providing the connection are below £3,400 or, where the costs are above £3,400, the customer agrees to pay the excess. [32] In calculating whether the costs are below or above £3,400, the Universal Service Provider (USP) must take into account where costs could be shared by several USO eligible premises. This is known as demand aggregation and to implement this, the USP is required to assume take-up by 70% of premises.[33]

Following a process of requesting expressions of interest from providers interested in being a USP, we designated BT as the USP for the UK (excluding Hull), and KCOM for the Hull Area, requiring them to provide the USO and to report at six monthly intervals on their implementation.

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[30] While coverage of both fixed networks and FWA networks has increased, and we have gathered data from more networks, last year we included data from the largest fixed and FWA providers (specifically MNOs). In addition, the data on premises has been updated and may include new build premises for which decent broadband will be available once complete but where the network connection has not been included in data provided by operators.

[31] The Electronic Communications (Universal Service) (Broadband) Order 2018

[32] In our statement of 6 June 2019 (para 5.1), we decided that an affordable service was one that cost £45 per month, rising annually by CPI. When the USO launched, this figure was £46.10.

[33] The conditions we imposed in our statement of 6 June 2019 require the USP to use a forecast of 70%, or actual demand if it is higher.

The broadband USO launched on 20 March 2020, very soon after the UK entered lockdown due to the Covid-19 pandemic.

BT's delivery of the broadband USO

Due to the Covid-19 pandemic, we agreed to a soft launch of the USO in order to manage demand on:

- BT's call centres, which were newly trained to support the USO;
- Openreach's employees that design and cost the network; and
- Openreach's engineers that ultimately build the network.

This meant that BT did not initially promote the USO in accordance with its obligations. However, it commenced promotional activities during the summer and has been writing to all potentially eligible premises.[34] We expect these communications to be largely complete by the end of 2020.

BT is required to report on its delivery against the USO. It published its first report covering the first six months of availability in October 2020.[35]

In the first six months, BT received 9,168 requests to its helpdesk. Of these, just over half (5,131) were deemed ineligible as there was already a service that meets the USO specification available (either from BT (3,190 requests) or another provider (1,739 requests)), or publicly funded schemes would provide a service in the next 12 months (202 requests).

Of the remaining requests, 512 orders were placed. These network builds will cover over 4,000 premises.[36] Of these, 507 orders were below the cost threshold of £3400 and so the customer did not need to pay any excess costs. Five orders were placed for build above £3400 where the customer agreed to pay the excess costs. As of September 2020, 7 premises had been connected under the USO scheme.

During this initial period of implementation, several issues have received attention:

- the clarity of information being provided to customers; and
- customers receiving very high quotes.

On the first of these, BT is working to improve its communications to customers, including to provide more information on alternatives to customers and to set out the costs of building the network to the customer more clearly.[37]

On the second of these, we understand that in some cases the costs to connect premises will be very high so that many customers are likely to receive quotes above the £3,400 threshold. In our statement in May 2020, we reported that BT estimated it would only be able to connect up to

[34] BT initially targeted communications activities to areas with least restrictions on its engineering workforce.
[35] BT, BT report on progress against the Broadband USO, 30 October 2020
[36] As infrastructure can often be shared, each individual order could mean network is put in place that can serve multiple premises. The network builds resulting from the 512 orders cover 4029 premises, which include 3245 in England, 253 in Northern Ireland, 111 in Scotland and 420 in Wales.
[37] See BT's October 2020 report.

16,000 premises below the £3,400 reasonable cost threshold.[38] Those premises that are more expensive to connect may need alternative solutions.

However, we are concerned that BT may not be complying with the regulatory conditions correctly where it assesses excess costs for a given connection. This could result in some customers' quote for a connection being higher than necessary. This could in turn lead to fewer people taking advantage of the USO. As such, we have opened an investigation into BT's approach to calculating quotes for excess costs.[39]

KCOM's delivery of the broadband USO

KCOM is the USP for the Hull Area. It received 1 request in the six months to September which it deemed ineligible, as a service meeting the USO requirements was available. KCOM considers that all premises within the Hull Area have access to a service that meets the USO specification. This is mainly due to KCOM's extensive rollout of full fibre, but those premises not covered by this rollout can be served using KCOM's copper network.[40]

Private and public sector investment play a role in building faster networks

Supporting investment in faster networks across the UK is a key priority for Ofcom. While commercial and public sector investment has delivered at least superfast services to most of the UK, not every part of the UK has the same access to faster speed services. Therefore, we are continuing our work to both improve access to better broadband services in the hardest to reach locations, and support investment in new gigabit capable networks.

Governments across the UK continue to supplement commercial rollout by investing in faster speeds for the hardest to reach areas. While subsidy schemes designed to bring superfast speeds continue to operate, governments are now also considering how public funding can be used to support gigabit-capable connectivity, a renewed emphasis which we expect to continue growing over the coming year and beyond.

We expect further public funding schemes to be announced during 2021 as the UK Government sets out further details of its £5 billion UK Gigabit Programme, with at least £1.2bn available up to the end of March 2025, to provide connectivity for the hardest to reach areas.

Examples of ongoing government schemes to support faster speeds in hard to reach areas include:

- The UK Government's Gigabit Broadband Voucher Scheme, which contributes towards the installation of faster connections using gigabit-capable infrastructure, alongside the ongoing Superfast Broadband Programme which will run until 2026.
- In Wales, Phase 2 of the £52.5m Superfast Cymru which is expected to provide gigabit capable technologies to around 39,000 premises by June 2022;

[38] Ofcom, Statement: Compensating providers delivering universal services - Ofcom, 22 May 2020.
[39] Ofcom, Investigation into BT's compliance with its obligations as a broadband universal service provider
[40] KCOM explained to Ofcom that it dd not consider any premises would be eligible for the USO because all customers can access either an affordable full fibre or a copper ADSL service. See Para 2.19, Ofcom, Statement: Compensating providers delivering universal services - Ofcom, 22 May 2020.

- In Scotland, the Scottish Government has committed to ensuring every home and business in Scotland can access superfast broadband. This commitment will be delivered through the Reaching 100% (R100) programme via three key strands of activity – the £600 million R100 contracts (North, Central and South), the Scottish Broadband Voucher Scheme (SBVS) and ongoing commercial deployment.
- In Northern Ireland, Project Stratum aims to bring next generation broadband to more than 76,000 rural premises across Northern Ireland currently unable to access speeds of 30 Mbit/s or more. The contract was awarded in November 2020 with work expected to start immediately and implementation will run until March 2024.

More information about schemes run by devolved government in the individual nations reports.

We will also conclude on our wholesale regulation that helps industry continue to deliver gigabit capable networks next year. Working with the UK and devolved governments, Ofcom will continue to focus on ways to deliver decent connectivity to all.

Future developments

We expect that the pace of gigabit-capable rollout will increase, both due to more full fibre deployment and Virgin Media's upgrade and extension of its network.

On fixed wireless access, WISPs are exploring using spectrum in higher frequency bands, which will enable them to provide services with higher speeds. There has been slow take up of access to the shared spectrum bands in 3.8-4.2 GHz, following our decision last year. We have also recently announced proposals for licensing high power access to spectrum in the 57-71 GHz band to support access to wireless broadband services.[41]

To date, the deployment of gigabit capable fixed wireless networks has been limited by the availability of affordable equipment, although this is expected to change in the next 12 months. Cambium Networks, a vendor used by many WISPs, has recently released equipment for the 60GHz band, capable of delivering gigabit speeds over wireless technologies.[42] This is based on wireless meshing technology developed by Facebook Connectivity's Terragraph project.

Satellite can be an option for a fixed broadband connection, particularly for premises without an alternative fixed provider.

Geostationary (GSO) satellites orbit the earth at around 36,000km, and can be used to provide satellite broadband to premises across the UK, including the most remote premises, but the connection's performance can be limited by its high latency, and by data caps that are commonly imposed on satellite broadband connections.[43] As such, we do not consider that GSO satellites currently provide a decent broadband service. In recent years, we have reported GSO satellite customer subscriptions in the low tens of thousands.

[41] Ofcom, Consultation: Notice of Ofcom's changes to licence exemption for Wireless Telegraphy Devices and consultation on licensing equipment in 57 to 71 GHz, 7 December 2020
[42] ISPreview, Cambium Networks Launch 60GHz multi-Gigabit Wireless Tech, 16 September 2020
[43] Latency refers to the time taken for information to traverse the network. Geo-stationary satellites tend to have high latency due to the signal having to travel the long distance to and from the satellite.

In future, we will likely see Low Earth Orbit (LEO) satellite constellations beginning to offer residential and business broadband to UK consumers, at the earliest during 2021. These services will have lower latency, because the satellites are closer to earth, so they are more likely to provide decent broadband services[44]. In November 2020, the UK Government completed its acquisition of OneWeb, a constellation of LEO satellites.[45] OneWeb will recommence launching satellites in December 2020 and anticipates offering an initial service by the end of 2021.

Over £1.1bn was invested in gigabit-capable full fibre access networks in 2019

We are reporting on provider investment for the first time this year

For the first time this year, we requested network capital expenditure (CAPEX) data from more than 30 of the UK's largest fixed and mobile telecoms providers to better understand how telecoms providers are investing in network infrastructure.[46]

This information was provided for the most recent annual financial reporting periods ending on or before 31 March 2019 and 31 March 2020. As financial reporting periods differ, we have pro-rated the data to estimate network investment in the calendar year 2019. The figures shown below include any public funding provided to support the rollout of better fixed and mobile connectivity, such as UK Government funding, funding provided via the governments of the devolved nations and local authority funding.

Our analysis suggests that providers collectively invested over £5.7bn in fixed and mobile network infrastructure in 2019.[47]

Investment in fixed networks

Data collected from over 20 of the UK's largest fixed telecoms providers suggests that UK telecoms providers invested around £3.5bn in fixed network infrastructure in 2019, with an additional £0.7bn having been invested in infrastructure that is used to provide both fixed and mobile telecoms services.

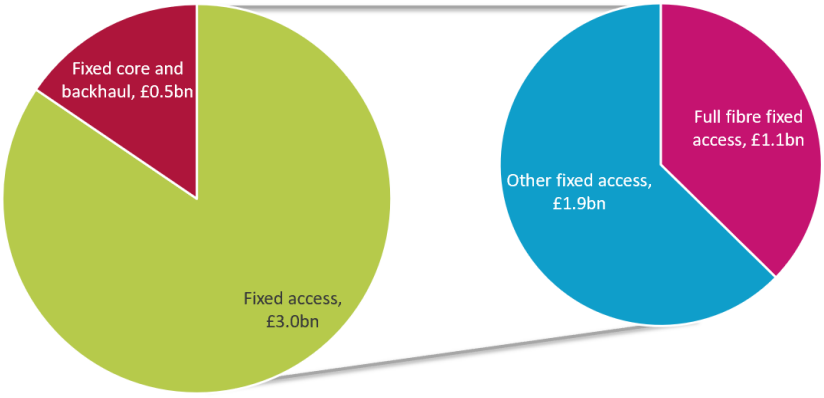
Fixed access network infrastructure accounted for most fixed network investment during the year (£3.0bn, or 84% of the total), with fixed core and backhaul networks accounting for the remaining

[44] SpaceX's Starlink LEO constellation launched a beta residential internet service in 2020. This service is currently only available in parts of the USA. We will consider the results of the beta trials when available.
[45] Department for Business, Energy & Industrial Strategy and UK Space Agency, UK government secures satellite network OneWeb, 20 November 2020
[46] Only Capital expenditure required to provide and operate network infrastructure in the UK is included: figures exclude VAT and expenditure on retail activities (e.g. retail billing or marketing systems). Figures include capital expenditure on tangible and intangible assets, including capitalised staffing and labour expenditure, and expenditure on assets in the course of construction (AICC). Figures exclude expenditure on assets that have been added to a balance sheet through adoption of the IFRS16 accounting standard, on assets held for sale and the costs of maintenance contracts purchased alongside hardware. Expenditure associated with asset transfers and leasing follows the same guidelines the Office for National Statistics provides when requesting information in its quarterly acquisitions and disposals of capital asset survey.
[47] We report on mobile investment in the mobile chapter.

£0.5bn (16% of the total). Gigabit-capable full fibre access network investment totalled £1.2bn in 2019, over a third of total fixed access network investment.

In addition, a proportion of the remaining £1.8bn may also support deployment of gigabit-capable networks where this is related to upgrades to physical infrastructure (such as fibre deployments for FTTC) that could be re-used in future.

Figure 9: Fixed telecoms network capital expenditure: 2019



Source: Ofcom / provider data

Data usage over fixed connections continues to grow

Consumers continue to use more data over their fixed connections as more people use broadband for data-heavy activities such as streaming. Average monthly data usage now stands at 429 GB per connection, up from 315 GB last year and 240 GB in 2018.[48] In addition to general web browsing and email use, a monthly usage of 429 GB could represent the download of a popular game, over 3 hours of video conferencing per working day, as well as over 3 hours per day of high definition video streaming. Average monthly download traffic has grown by around a third in the past year, whilst peak download traffic (in the period 6pm to midnight) has grown by around a quarter. The figures for this year were recorded during the Covid-19 pandemic.

More consumers are upgrading to higher speed packages

The benefits of increased coverage of broadband networks able to support higher speed services cannot be realised if consumers do not take advantage of these services when they are available. So alongside reporting on the extent of coverage of broadband networks we also examine the take-up of services over them.

[48] These figures include connections not assigned to a specific location within the UK; equivalent figures in Nations reports include only connections assigned to addresses in that Nation. The UK average given here therefore includes data for premises not included in the figures given for each individual nation in the Nations reports.

Of those properties for which we have accurate address matching, broadband provider and speed data from both 2019 and 2020, we observe that more are taking higher speed packages than last year. [49]

Overall, we estimate that for those premises that are able to take superfast broadband or a higher speed (96% of all premises in the UK), around 60% / 16.7million of them do so. This is an increase from around 57% last year.

We estimate that the take-up of services using full fibre at any speed, where fibre is available, is around 25%. [50] This is lower than the 2019 estimate, which is likely to be due to the high rate of full fibre deployment over the past year (2m additional properties) with adoption increasing at a lower rate.

The take-up of gigabit speed broadband services in the UK is currently low, which makes quantifying this with accuracy difficult, given the subset of properties for which we obtain accurate speed data. However, gigabit capable broadband services are becoming increasingly important in the UK and we will be considering how best to report on both their availability and take-up for future publications.

We have also examined the extent to which consumers have changed their broadband package over the past year:

- For those properties that last year took a sub-10Mbit/s broadband service (at least 2.2m), just under 40% of these were now, in 2020, taking a broadband package that offers decent broadband speeds (>10Mbit/s) or better.
- For those properties that in 2019 were taking a package with speeds between 10Mbit/s and 30Mbit/s (decent broadband) (at least 3.7m), this year just under 30% of these are now taking superfast (or better) broadband.
- The vast majority (>90%) of properties taking superfast services in 2019 (at least 12.4m) were still taking these services in 2020.
- Conversely, just under a fifth (18%) of properties taking ultrafast (>300Mbit/s) services in 2019 (at least 390,000) were, in 2020, taking a slower speed broadband package.

Switching broadband provider can be a catalyst to upgrading to higher speed broadband. For those properties that have remained with the same broadband provider over the past year, around 85% have remained largely in the same speed category, with 10% increasing their speed. However, for those that have changed broadband provider over the past year and signed up to a new deal, well over 20% increased their speed when doing so.

Overall, many consumers have the opportunity to take higher speed broadband packages if they choose to do so. The broadband package selected by consumers will be a matter of individual choice and will depend on a variety of factors, of which network availability is just one.

[49] See methodology Annex for details. Accurate premises-level usage data for which we were able to address match in both 2019 and 2020 is available for around 2/3 of the total premises in the UK.
[50] This take-up figure refers to the underlying technology; customers can often choose a range of speed tiers over full fibre technology.

We may also see users' needs evolving; as they come to rely more on fixed broadband connections for essential participation in digital society, they may need faster and more reliable connections to do so.

Installation times for full fibre connections

The coverage information we publish, both in this report and our associated maps and open data, shows where connections at the speeds indicated are available. For broadband services using the telephone line, such as standard broadband, the connection usually already exists to the property. However, in the case of full fibre connections, the network provider may have installed network close to the property but still needs to install the final connection to a property in order to provide service.

We asked full fibre providers the length of time it would take to make this connection. We found that there was a broad range of installation times. For those providers that provide fibre networks to new-build and campus developments, connections are built into the fabric of the properties, and hence connection times are effectively instantaneous. In general, we found that almost all operators were able to provide connections within 28 days of a customer order. In some situations, longer connection times may arise, either because of the geography (such as accessing very rural communities) or due to gaining necessary wayleave permissions.

Capacity to deliver broadband services

In some circumstances it is not possible to provide a broadband service to a new customer even though there is network coverage. This can arise because the network in the area is reaching the limits of its capacity, and therefore requests for service at the desired speed cannot be met. It may also arise if additional connections exceed the physical number of ports on equipment in the access network (such as a street cabinet or exchange equipment).

In our 2019 report, we estimated that across the UK, fixed access networks had the capacity to meet additional demand from users 99% of the time. We said we would use this as a baseline to monitor how providers met changing user needs over time, particularly as demands on providers remain to grow coverage, as well as to maintain and repair existing networks.

Similar capacity constraints were found this year, with more network providers reporting some, albeit low levels of capacity limitations. This suggests that as new entrant network providers reach maturity at scale, they too face the same challenges of network operation and management as the more established networks.

Helping customers choose the right broadband service

Ofcom has work underway to help consumers understand their broadband choices, and to see the potential benefits that faster connections may give them. Ofcom's Boost Your Broadband campaign seeks to help customers understand the broadband choices available to them, and to understand the additional benefits of a faster connection.[51]

[51] Boost Your Broadband

We have also worked to help consumers know when their contract period is coming to an end. Since February 2020, providers have been required to issue End of Contact Notifications, which tell people when their contract is coming to an end, what they will pay when it does, the best deals their provider can offer them, and that they have the choice to switch providers at the end of their minimum contract period if they wish.[52] Additionally, for out of contract customers, providers are required from February 2021 to issue Annual Best Tariff Notifications to out of contract customers, telling them that they are out of contract and the best tariffs they can offer.

Full fibre and gigabit-capable connections are still relatively new to UK consumers. In August 2020, the UK Government convened a new taskforce ('GigaTAG') to drive consumer take-up of gigabit speed internet connections.[53] Ofcom is participating in this work and will continue to work with industry, governments and consumer bodies on communicating the benefits of gigabit-capable technologies as they become more widely available.

The UK's traditional telephone network is also being replaced

It is not only the UK's fixed broadband networks that are changing – traditional landline services are also undergoing a substantial transition. Network providers such as BT, Virgin Media and KCOM, that offer traditional telephony services (referred to as the Public Switched Telephone Network, or 'PSTN'), are in the process of retiring their legacy systems and replacing them with modern systems.[54] In particular, BT plans to retire its PSTN network by the end of 2025, with fixed voice services delivered to customer homes or business premises delivered over broadband connections instead. Before the PSTN switch off in 2025, all fixed voice services will need to migrate to alternative voice services over broadband.

Last year we estimated that only around 1% of voice lines were being provided over broadband, reflecting the early stages of migration. This year, analysis of provider data shows that around 8% of fixed voices lines are delivered over broadband, as the larger communications providers begin to offer these alternative voice services to their customers. We anticipate that adoption of these services will increase rapidly in the next few years and are working with providers to address any issues that might arise with this migration to ensure consumers are protected and disruption is minimised.

The introduction of new voice services and platforms brings associated opportunities and challenges. Consequently, we are looking into how the telephone numbering scheme may evolve and considering other numbering related issues – such as call routing, number portability and trusted caller line identification.[55] The migration from the legacy telephone network also brings challenges in terms of the reliability of services, and the devices that take advantage of the traditional telephone network's line powering and voiceband data transfer capabilities (like telecare alarms, and telemetry and monitoring applications within critical national infrastructure). We discuss these in more detail in the Security and Resilience chapter.

[52] Ofcom, Companies must tell customers about their best deals, 14 February 2020
[53] DCMS, Press release: Gigabit broadband rollout milestone reached, 8 August 2020
[54] In the case of BT, PSTN services are provided by Openreach in terms of access connectivity and BT for calls services. Openreach's WLR withdrawal site gives more information.
[55] Ofcom, First consultation: Promoting trust in telephone numbers, 11 April 2019



Mobile data and voice

Introduction

Mobile services are an important part of people's daily lives. The experiences of the Covid-19 pandemic over the course of this year have further emphasised the reliance society and business place on access to good mobile services, and the key role these services play in helping people communicate and stay in touch.

In this chapter, we report on the impact of the Covid-19 restrictions on the use of mobile services. We also provide an update on the availability of mobile coverage, including the continued rollout of 5G, coverage outside and inside premises, across the UK's landmass and on roads. We also address investment in, and the take up of these services, as reflected in the continuing growth of mobile traffic year on year. Finally, we also report on the availability and use of 'Internet of Things' devices and services, which have continued to increase over the past year.

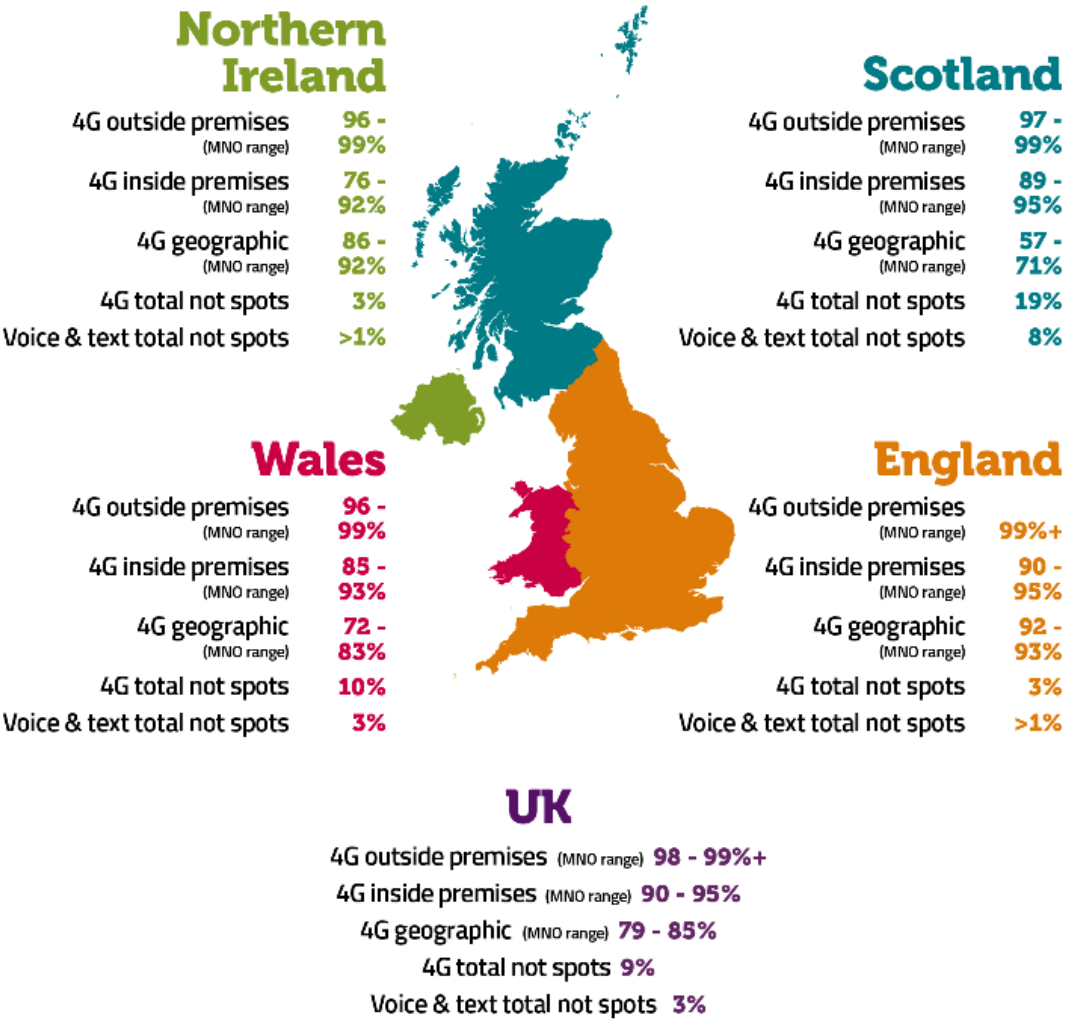
Key highlights:

- There was an increase in call volumes and average call duration in the week the national lockdown was introduced in March 2020, which networks successfully handled. As restrictions continued, mobile hotspots shifted away from the city centres to the suburbs and residential areas.
- 170,000 cumulative hours of service were lost as a result of attacks on mobile base stations - based on false conspiracy theories incorrectly linking 5G to the coronavirus and other health concerns - during this period.
- 5G deployments have continued, particularly in locations with existing high demand for mobile services. There has been around a ten-fold increase in 5G enabled base stations, with around 3,000 base stations now live for 5G services across the UK.
- 4G coverage has not significantly increased across UK premises and geographic areas, while there continues to be significant differences across the nations. MNOs have now moved into a detailed planning phase for the implementation of the Shared Rural Network (SRN) programme which will improve coverage across the UK landmass, particularly in rural areas, in the years ahead. Other public policy interventions such as the Scottish Government's 4G (SG 4G) Infill programme are also supporting increased rural coverage.[56]

[56]Scottish Government, Improving mobile coverage, 12 March 2020

- Mobile data consumption continues to rise, increasing by 42% compared with last year. 83% of the total data traffic was consumed in England with about 10% in Scotland, 4% in Wales and 3% in Northern Ireland (largely in line with UK population distribution). Reflecting this growth, the traffic carried in England in June exceeded that carried across the whole UK in February.

Summary of mobile coverage across the UK and nations[57]



[57] In providing these ranges we have rounded coverage to the nearest whole number, except where that whole number would imply 100% coverage. Fuller details on coverage levels can be found throughout this report and our accompanying interactive publication.

The UK's mobile networks successfully coped with increased traffic demands and changes in consumption patterns during Covid-19

Data usage during Covid-19

UK MNOs coped successfully with the changes in data and voice traffic volumes and distribution as many people began working from home and schools were shut during the Covid-19 spring lockdown. New peaks were reached for most of the network metrics reported by MNOs just before or during the week lockdown measures were first introduced across the UK in March 2020.[58, 59] Although these peaks generally reduced with the gradual easing of lockdown, they have remained higher than they were before (in line with the historical trend for incremental growth in data consumption).

The MNOs all experienced some form of congestion on their networks in this period, but successfully mitigated this, in part by increasing interconnect capabilities between themselves. Some operators applied further temporary upgrades to their voice and data capabilities in order to cope with increased demands during this period, for example deploying temporary base stations in and around hospitals (particularly at the Nightingale hospitals) to provide additional capacity.

Compared to periods before the spring lockdown, mobile voice traffic increased by 10-45% across the operators. [60] One operator observed an increase in average call duration from about 2.5 minutes (pre-lockdown) to 4 minutes in the week lockdown measures were introduced. These call lengths and volumes spiked in March, before gradually stabilising. Within this general trend for growth, we can also observe drops in average call duration and data traffic around 8pm for the 10-week period from 26 March 2020, coinciding with the nation coming together to applaud the efforts of the NHS during the Covid-19 crisis. Increased amounts of voice traffic were also offloaded to Wi-Fi, although with significant variations between operators. Compared with periods before lockdown, offloaded voice call volumes rose by a minimum of 16% and a maximum of 97% (we note that these increased levels still represented a relatively small part of total call volumes, ranging between 2% and 8% in this period). These dropped with the easing of lockdown but have in some cases remained up to 50% above pre-lockdown values.

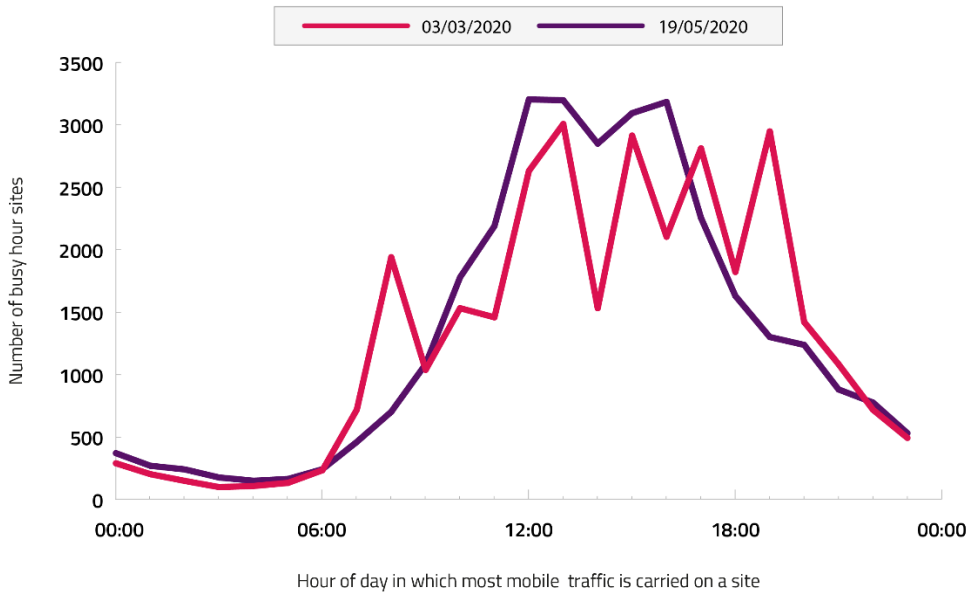
Mobile data traffic fell in the week lockdown measures were introduced across the UK. Crowd sourced data available to us suggest that the reduction in overall data traffic across the operators reflected more users being at home and offloading their data to home Wi-Fi connections. [61] Unlike Wi-Fi mobile voice call offload, which can require prior registration with MNOs, consumers only

[58] We have assessed the impact of Covid-19 on mobile networks by comparing MNO data for the second week of March 2020 (as a baseline) with those collected in the week lockdown measures were introduced in the UK and the periods after these measures were eased. We collected relevant data from MNOs between February 1- July 31, 2020. We have also clarified where we have considered data from other sources.
[59] This analysis does not include data from one UK MNO.
[60] In terms of the proportion of total minutes of originated calls.
[61] The dataset was licensed to Ofcom by network benchmarking specialist Umlaut and contains information on mobile user experience and network performance. The operating system used on iPhones (iOS) restricts the collection of network performance data by background apps, so the data in this report relate to Android devices only. These devices are predominantly smartphones, although there are a small number of tablets and other Android devices with a SIM card

need to be connected to Wi-Fi networks in order to offload their data to them, meaning significantly more data traffic offloaded to Wi-Fi than voice calls.

Consequently, the operators experienced an initial reduction of between 4% - 20% in the volume of data downloaded over their networks in the early weeks of the spring lockdown. However, these volumes recovered as lockdown restrictions eased and have generally stabilised at a level higher than before lockdown, reflecting the value people placed on mobile connectivity as they were out and about more frequently but sought new ways to connect and engage as social distancing requirements remained in place. The change in people's daily patterns also impacted the peaks in mobile traffic, with the 'busy hour' on mobile base stations more evenly distributed after the lockdown than before, when peaks were typically staggered around 8am (morning commuting), 12-1pm (lunch breaks) and 5pm (return commute), in line with historic trends.

Figure 10: Busy hour distribution for periods before and after lockdown restrictions for one operator

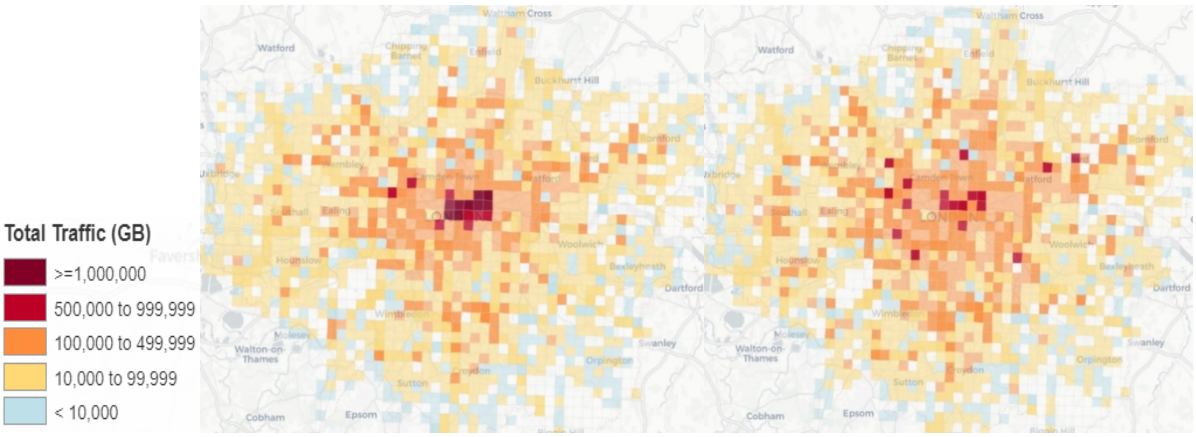


Source: Ofcom analysis of operator data

Mobile hotspots shifted from urban areas to suburban areas during lockdown

This change in people's daily lives also saw mobile traffic patterns (voice and data) shift from the city centres (urban areas) to more residential areas (suburbs) during the period, particularly as people began working from home. Figure 11 below shows the shift in all traffic from the city of London to more residential areas by comparing periods before and after the Covid-19 spring lockdown. On the left we show data from February 2020, before restrictions were introduced. On the right we show data reported to us for June 2020, when the heaviest restrictions had been lifted but the UK Government's social distancing measures, with associated changes in people's behavioural patterns, were on-going. This can be seen in the redistribution of mobile traffic from the centre of London, where traffic levels fell substantially, out across a more residential ring.

Figure 11: Variations in MNO data traffic distribution in London (February 2020 and June 2020)[62]



Similar trends were observed across other major cities.

MNO Base Stations were attacked due to false Covid-19 conspiracy theories

Over this year, a number of unsubstantiated claims have circulated, often through social media, alleging a link between new 5G services and Covid-19 (notwithstanding that 5G deployments are at a relatively early stage in the UK, and have not taken place in many of the countries impacted by the pandemic). Prior to this, there were also false claims that the Electromagnetic Field (EMF) emissions of 5G base stations posed an increased risk to people's health.[63]

MNOs reported attacks on 159 base stations associated with anti-5G or similar campaigns during this period. In several instances, the operators had restricted access to the affected base station during this period, resulting in around 170,000 cumulative hours of base station down time across all operators.

Earlier this year, Ofcom published our findings on EMF measurements we carried out around 22 locations near 5G mobile phone stations across 10 cities in the UK including Belfast, Cardiff, Edinburgh and London.[64] We found that in all cases that the measured EMF levels from 5G-enabled mobile phone base stations are small fractions of the levels identified in the International Commission on Non-Ionizing Radiation Protection (ICNIRP) Guidelines, with the highest level recorded being approximately 1.5% of the relevant level. [65]

Our findings are also consistent with those of Public Health England (PHE) which states that overall exposure due to 5G is expected to remain low and within the guidelines (ICNIRP) and, as such, there should be no consequences for public health.[66]

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[62] This map is based on all traffic carried on all mobile networks. London has been divided up into 1km^2 tiles and traffic allocated to the tile in which the base station carrying traffic is located.
[63] Ofcom has published a statement setting out our plans to include a specific condition in Wireless Telegraphy Act licences requiring licensees to comply with the ICNIRP general public limits on EMF exposure. See
[64] Ofcom, Electromagnetic Field (EMF) measurements near 5G mobile phone base stations: Summary of results, 21 February 2020 (updated 17 April 2020)
[65] Guidelines for limiting EMF exposure that will provide protection against known adverse health effects are published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). ICNIRP is formally recognised by the World Health Organization (WHO).
[66]Public Health England, 5G technologies: radio waves and health, 3 October 2019

Progress with 5G continues despite the pandemic

Since the initial roll out of 5G networks last year, UK MNOs have continued to deploy 5G, largely on existing mobile infrastructure. The main focus of this activity has remained predominantly in urban areas where such deployments provide additional capacity in areas of high demand, although wider deployments have taken place. This is in line with our expectations, with current 5G deployments for consumers largely focusing on delivering mobile broadband, particularly in areas of existing high demand. The potential of 5G networks to deliver other benefits, particularly those depending on its ultra-low latency capabilities are increasingly being explored by businesses. For example, MNOs have been collaborating with various industries to monitor and maintain critical assets and accelerate the digital transformation of these industries.[67] [68] Over time we expect a range of models will contribute to meeting different types of demand from both consumers and businesses, with private networks playing an increasing role in providing mobile connectivity.

Take up remains a relatively small proportion of overall users, with about 800,000 active 5G devices across all mobile operator networks in the UK (as of early September 2020). This represents just over 1% of all active devices. As new services emerge, and more 5G handsets become available, take up is likely to increase across the UK.

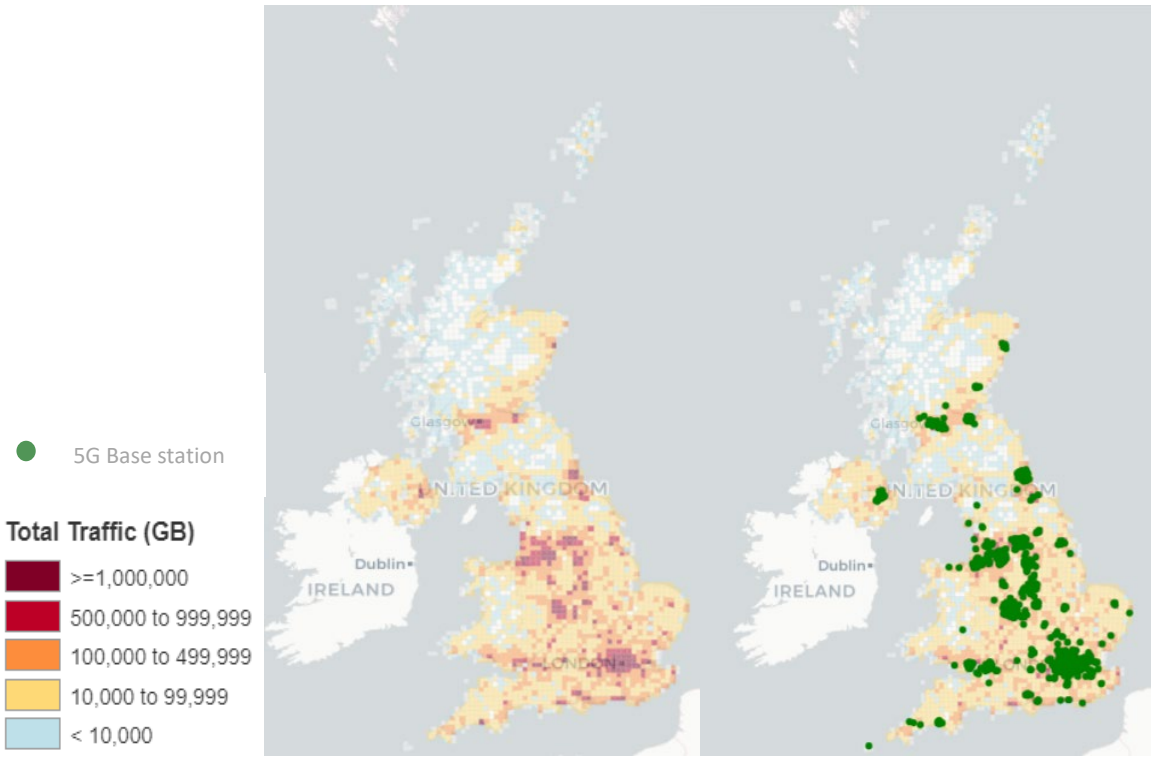
Across the UK, 5G is now carried on around 3,000 mobile base stations (around a ten-fold increase in base stations reported to us last year), with 87% of these base stations in England, 7% in Scotland and 3% in both Wales and Northern Ireland.[69] These deployments mean 5G is available on just over 8% of all urban mobile base stations, and around 1.5% of all suburban mobile base stations.[70]

We have found that the majority of current 5G deployments are in already busy areas and are providing capacity enhancements to other mobile generations i.e. 4G.

Approximately 50% of all 5G deployments have occurred within the 5,000 busiest sites (in terms of total traffic carried) across the existing UK mobile grid, emphasising that in many cases – but not exclusively – 5G is being deployed in high demand areas. In figure 12, we show how mobile traffic volume varies across the UK and is broadly followed by the pattern of 5G site deployment.

[67] Vodafone, Centrica Storage chooses Vodafone Business technology to build the gas processing plant of the future, 4 August 2020
[68] BT, Belfast Harbour and BT to build the UK and Ireland's first 5G Private Network for ports, 27 October 2020
[69] Note that for the purposes of this report, the reported tally of 5G base stations represents a tally of all individual MNO deployments, and should two MNOs have added 5G services on the same physical structure, we regard this as 2 sites.
[70] We note that the data indicating around 3,000 base stations carrying 5G is based on the most recent information available from MNOs in September 2020. More detailed analysis on the distribution across existing busy sites, and across rural and urban areas, comes from a slightly earlier, but more detailed dataset based on the situation as of June 2020.

Figure 12: illustration of base station monthly traffic volumes and base station with 5G deployed on them



As can be seen above, the early deployment of 5G on MNO networks is largely capacity-driven, although, like older cellular generations, we expect 5G will achieve wider availability over time. This could be enabled by the deployment of the 700MHz band over time (although we note that the 700 MHz band will not support as much capacity as the 3 GHz band), as well as the possibility of sharing and re-farming of spectrum currently used for 2G, 3G and 4G networks for 5G [71]. We note that 5G networks in the UK have been rolled-out in non-stand alone (NSA) mode and are therefore currently unable to provide services independently of other coverage layers, with voice services continuing to rely on Voice over LTE (VoLTE) or circuit switched fallback and 5G data services also requiring a 4G "anchor". [72]

While our findings show 5G rollout continuing, the UK Government has indicated it considers progress may be slowed by new requirements to limit fresh deployments made using High Risk Vendors. [73] [74] The UK Government has now published its diversification strategy, setting out its plan to build an open, innovative and diverse 5G supply chain, and Ofcom is engaging with this work to

[71] 700MHz, 3.6-3.8GHz spectrum auction will provide additional spectrum for the deployments of 5G
[72] In Non-Stand Alone (NSA) deployment, the radio interface is 5G, but the core network is based on 4G. In Stand Alone mode, both the radio interface and core networks are based on 5G and is completely independent of 4G networks. Operators have initially deployed 5G in NSA mode because standardization for NSA was completed first and it also allowed them to provide 5G using existing 4G core network infrastructure.
[73] High Risk Vendors are those who pose greater security and resilience risks to the UK telecoms networks, as set out in the UK Government Supply Chain Review
[74] Hansard, UK Telecommunications: Volume 678: debated on Tuesday 14 July 2020

ensure the regulatory landscape does not present any impediments to the arrival of new vendors, or the development of a new Open RAN eco-system.[75][76]

5G has started delivering benefits beyond capacity enhancements

We expect MNOs to leverage other benefits of 5G as they continue to rollout their networks and to provide connectivity solutions for both consumers and businesses. This includes private networks for businesses, which will facilitate greater control and privacy in addition to connectivity.

5G will continue to target a range of other applications (e.g. manufacturing, logistics, agriculture, automotive, energy, media & entertainment and healthcare sectors) to deliver benefits to consumers, businesses and organisations. 5G (3GPP Release 16 & 17) has features such as near instantaneous network response (a latency of only a few milliseconds) and high reliability which are key enablers for these applications (although instant response capabilities require a transition to standalone 5G deployments and to a 5G core, and moreover may require some core functionalities to be deployed at the edge to be fully realised).[77] As we noted in the fixed chapter of this document, we are also seeing some early offerings of Fixed Wireless Access based on 5G solutions.

5G and industry case study

- Businesses and enterprises across the UK are starting to explore the benefits of 5G through the deployment of non-public networks. These networks allow organisations to have total control over their operating process in addition to guaranteeing quality of services particularly through the dedication of resources. One such network in the UK is the Worcester Bosch factory.
- The network is helping Worcester Bosch drive productivity through preventive maintenance and robotics, both of which are dependent on the enhanced speed, reduced latency and high network availability of 5G. Typically, data collected from large numbers of sensors which monitor machine conditions, is sent across the 5G network and analysed in real-time, thereby reducing response time to potentially critical failures.

Earlier this year, the UK Government announced a multi-million pound investment in 5G testbeds and trials across the UK to explore potential benefits of 5G in improving the lives of people in rural areas and maximise the productivity of industries.[78] MNOs are collaborating with UK local councils, businesses and other stakeholders to deploy 5G under this initiative.[79, 80, 81] Independently, they are

[75]DCMS, Guidance: 5G Supply Chain Diversification Strategy, 30 November 2020
[76] Open RAN introduces an open standard for developing Radio Access Network technology, meaning that all suppliers could develop interoperable products and components. It enables operators to deploy equipment from multiple suppliers in the same configuration - utilising software and virtual solutions - allowing them to choose the best equipment suppliers for a particular component of the RAN to suit their particular deployment requirements or needs.
[77] The 3GPP is a global consortium of standards organisations which develop protocols for mobile telecommunications. The Releases describe evolution of mobile standards to support new features/
[78] DCMS, Press release: New £65 million package for 5G trials, 20 February 2020
[79] ISPreview, Government Hand £65m to New UK 5G Mobile Broadband Trials, 20 February 2020
[80]BT, BT Accelerates the Next Phase of UK's First Live 5G Private Network for Industry 4.0 and Smart Manufacturing 21 July 2020
[81] Vodafone UK News Centre, How Ford and Vodafone are creating the 5G 'factory of the future, 25 June 2020

also trialling 5G for the delivery of remote health, virtual reality (VR) based education and entertainment.

Availability of 2G, 3G and 4G mobile technologies and services

In this section we report on coverage both outside and inside premises, on geographic coverage and on coverage along roads.

In previous reports, we have also reported on coverage across the rail network. However, minimal improvements in 4G coverage (which we discuss in more detail below) on which it is dependent, has meant that rail coverage is currently relatively static. We continue to work with the sector and UK Government to address rail travellers' connectivity needs.

Merseyrail case study

The Liverpool City Region Combined Authority is leading on a multi-million-pound programme to introduce a new fleet of state-of-the-art trains for the Merseyrail network. As a key part of its fleet replacement project, it is introducing a dedicated Train Connectivity and Information System (TCIS) which will drive operational efficiencies, improve passenger safety and, as a by-product, provide high speed Wi-Fi connectivity for passengers. The TCIS will provide high-capacity connectivity to all trains throughout the network, including tunnels, using a 432-fibre cable to interconnect around 150 track side radio link units and on-board equipment with sets of antennas at each end of the train. The TCIS will provide high-quality, real-time CCTV, passenger information feeds, diagnostics and voice links between the trains and the control centre and allow passengers to use much of the normally spare capacity through in-carriage Wi-Fi. The solution will also allow British Transport Police (BTP) live remote CCTV access on board the train. The project is due to be completed in 2021.

Methodology

Below we report on the availability of voice services, via either 2G, 3G or 4G, and on the availability of 4G data connections.[82] The mobile coverage figures provided in this report are based on predictions which the MNOs supply to Ofcom, with Ofcom undertaking regular testing to ensure the predictions provided are suitable for national and regional reporting. We take the accuracy of the data supplied to us seriously and we continue to monitor, through drive testing, the accuracy of all operators' coverage predictions. We note that operators continue to update and improve their prediction models, and we welcome this. The data used in the report includes predictions provided to us by O2 using a newly developed coverage prediction model, which are still subject to Ofcom's validation process. In light of our own drive testing, we are continuing further discussions and work with O2.

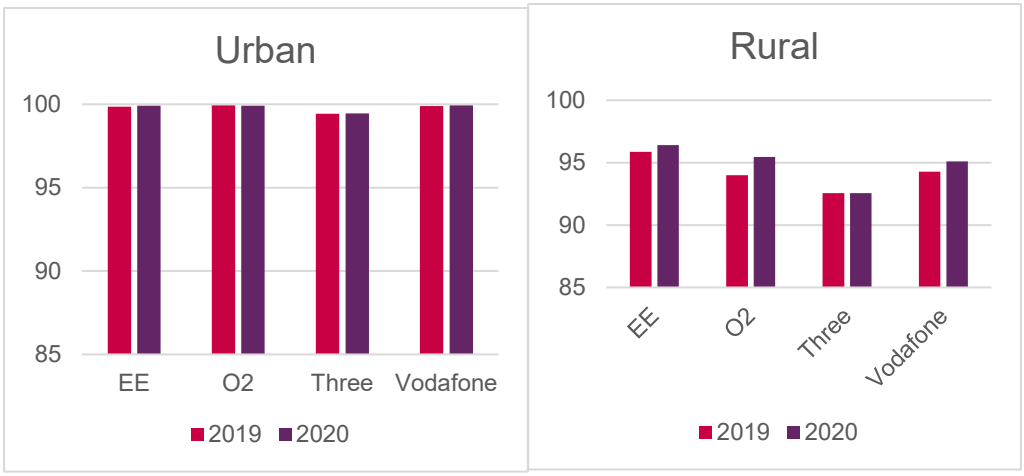
[82] Our definition of 4G coverage reflects a level of service that supports nearly all 90-second telephone calls being completed without interruption and data connections that should deliver a connection speed of at least 2 Mbit/s (fast enough to browse the internet and watch glitch-free mobile video) almost all the time.

Coverage outside premises

As with last year, over 99% of UK premises have coverage for mobile telephone calls from all operators while almost all UK premises have coverage from at least one MNO. Similarly, outdoor 4G data services from all MNOs remain available at 97.5% of UK premises and almost all UK premises have coverage from at least one MNO.

However, there are differences between coverage in urban and rural areas. Outdoor coverage for mobile telephone calls remains available at almost all urban premises, compared with 95% of rural premises. For 4G data services, coverage remains available from all operators outside 99% of premises in urban areas, compared with around 87% of rural premises. This is a small increase from last year, and our analysis indicates that this in part reflects increases in O2's predictions for rural coverage stemming largely from the new prediction tools it has adopted, and small increases across EE's and Vodafone's rural coverage footprints as well, as can be seen below in figure 13.

Figure 13: Outdoor premises coverage of 4G data services in the UK



Source: Ofcom analysis of operator data

Indoor coverage

The coverage people receive indoors will depend on a range of factors including: the thickness of walls, building materials used in construction and where in a building people are using their phone. In some premises there may be differences between our predicted indoor coverage data and the actual coverage available. Our online coverage checker provides additional information on the likelihood of there being indoor coverage in buildings at different locations, which takes into account some of the factors that can affect a mobile signal.

We estimate the availability of indoor mobile coverage for calls to have remained unchanged from last year. [83] While almost all premises have indoor coverage for calls from at least one operator, calls

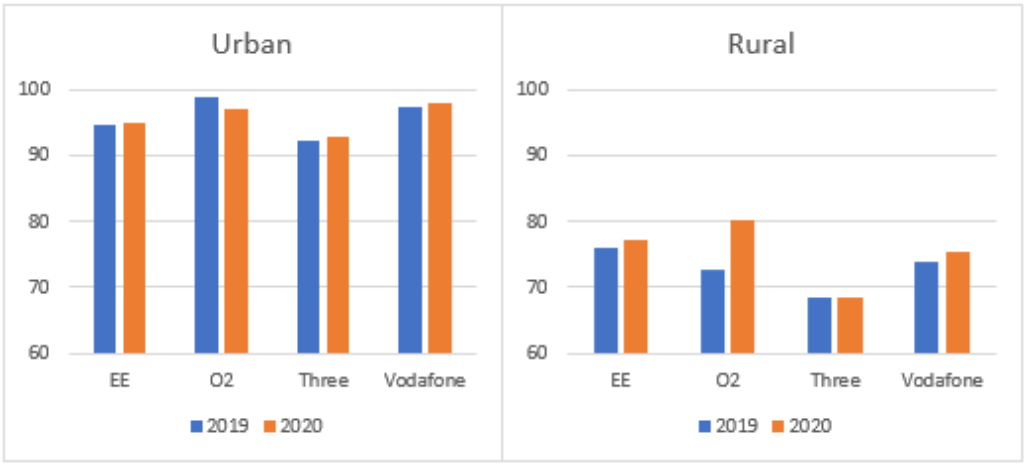
[83] We determine indoor coverage by applying an average building entry loss of 10dB across buildings. We acknowledge that this approach provides only a simplified view of what levels of indoor coverage might be, with the real experience in a building depending heavily on the types of building material and insulation in a given premises. Ofcom is engaging with mobile operators to determine if and how a more granular estimate can be developed.

from all operators are only available indoors across 93% of premises. Similarly, 99% of premises have indoor 4G coverage from at least one operator, while all operators are predicted to offer 4G data services indoors to 80% of UK premises.

Indoor voice coverage remains poor in many rural areas, and only 70% of rural premises have coverage from all operators. In comparison, indoor coverage in urban premises remains available at 97% of premises from all operators. While mobile call services are available from one or other of the providers in 99% of rural premises, there is a difference of about 16% in areas covered by individual operators.[84]

Coverage for 4G data connections are also lower in rural areas, with only 46% of rural premises predicted to have indoor 4G data coverage from all operators, compared with 86% in urban areas. However, when we look at the coverage from individual MNOs, which reflects the experience available to consumers with a service from a given operator, we can see the coverage levels are somewhat higher, with urban coverage ranging between almost 93% and almost 98%, and rural coverage ranging between 68% and 80% of premises indoors.

Figure 14: Indoor premises coverage of 4G data services in the UK



We note that on the basis of the individual MNO coverage shown in figure 14 above, 4G coverage is predicted to be available indoors from at least one operator in almost all urban premises and in 95% of rural premises.

MNOs provide a number of alternative options to improve the indoor mobile coverage experience. All the MNOs in the UK make Wi-Fi calling services (the ability to make and receive a call over a Wi-Fi network) available to consumers, and although not all mobile phones support this feature, the percentage of calls made using voice over Wi-Fi by MNOs has increased to between 2% and 18% per MNO (up from 0.2% to 12% last year).[85] Other examples of available tools include broadband-based calls on services such as Skype/WhatsApp, and femtocells. In 2018 Ofcom also introduced

[84] Reductions in indoor coverage can be the result of re-use of 3G spectrum for 4G services (when accounting for the different thresholds applied) and the in-building penetration losses that apply to signals at these frequencies.

[85] There are two types of Wi-Fi calling solutions: "cellular preferred", where the devices use Wi-Fi calling only if there is poor cellular coverage, and "Wi-Fi preferred" where all the calls are made via Wi-Fi, when Wi-Fi is available. All UK MNOs use the Cellular-preferred solution.

regulations that allow the licence exempt use of certain types of mobile repeaters, which can amplify the signal received outside a building and thus improve consumer experience indoors (devices not meeting these specifications remain unlawful). [86, 87]

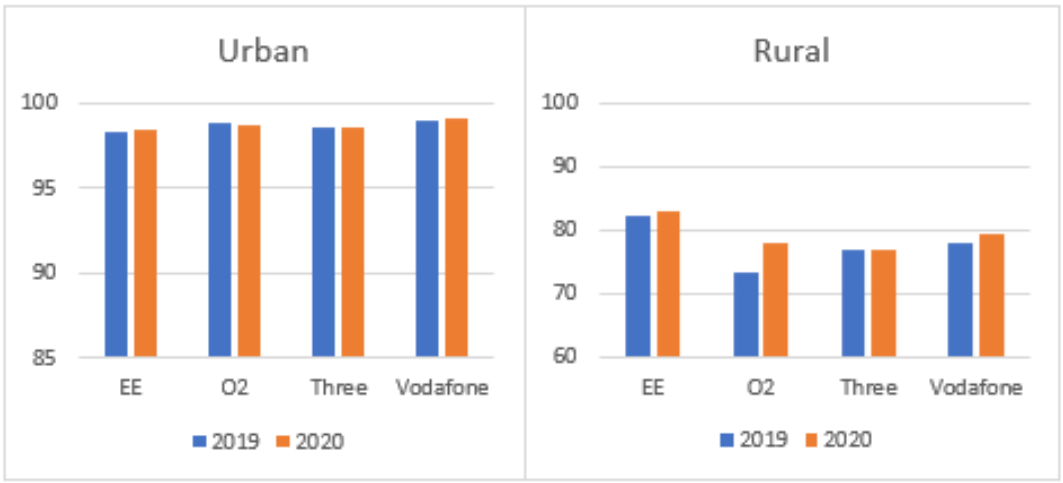
Geographic Coverage

We noted in last year's Connected Nations report that the growth in 4G geographic coverage had begun to plateau, with small increases in individual operator coverage, but no substantial changes overall. This remains the trend for this year, with differences remaining between the coverage offered by individual operators, and with good consumer experience limited by the presence of enduring 'partial not spots' (i.e. areas not covered by all operators), predominantly in rural areas. The announcement of the Shared Rural Network in March 2020 should see around £1billion of combined public and private funds invested in addressing these problems and improving rural coverage for the UK. However, there has only been limited coverage gains over the course of this year, as the SRN completes detailed planning work before shifting focus to delivery.

There are significant differences between the MNOs. BT EE increased its 4G geographic coverage by around 1% to about 85% of the UK, the most of any MNO, while the operator with the lowest coverage predictions (Three) provides coverage in around 79% of the UK's geographic landmass.

These differences are less significant in urban areas , with all operator coverage here in the 98-99% range nationally, whereas rural landmass coverage ranges from around 77% to almost 83%.

Figure 15: Outdoor area coverage of 4G data services in the UK



We note that the increase observable in rural coverage predicted by O2 may be largely attributable to the new prediction model they have adopted, as opposed to significant new network build.

As a result of these MNO footprints, 4G coverage from at least one operator remains at 91% of the UK landmass and consequently 9% of the UK landmass continues not to have good outdoor 4G coverage from any operator. The availability of 4G data services from all four MNOs is reported as having increased to 69% of the UK's geographic area, although our initial analysis indicates that the

[86] Mobile phone repeaters – what you need to know, 12 April 2018.

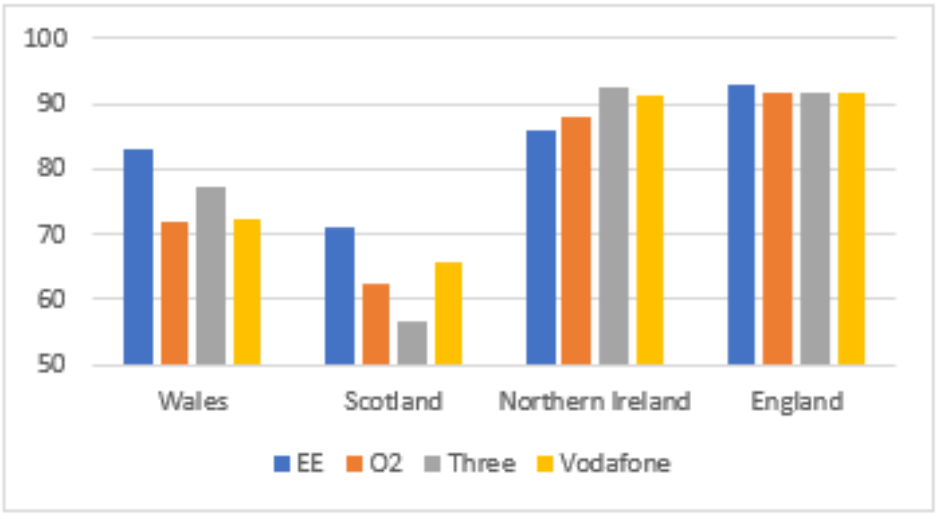
aforementioned changes in prediction tools, rather than new site deployments, may be a significant contribution to this change.

Differences across the nations

In line with the broadly static nature of coverage expansion before SRN deployment begins in earnest, there remain significant differences across the nations. 4G data coverage remains as a whole lower in Northern Ireland, Scotland and Wales than it is in England, varying considerably among mobile operators and remaining poor in many places. Today only 60% of Wales and 44% of Scotland can receive 4G data services from all MNOs. In comparison, these services are available from all MNOs in 79% of geographic areas in Northern Ireland and 84% in England.

Whilst the trend for differences in coverage between the nations is also reflected in the coverage provided by individual MNOs, the coverage levels from operators tend to be higher and reflect the actual coverage available to a consumer on a given network in each nation. We also note that some areas without coverage are very remote - for example, 20% of Scotland is considered 'wild' by Scottish National Heritage.[88]

Figure 16: Differences in 4G data geographic coverage in Wales, Scotland, Northern Ireland and England



Source: Ofcom analysis of operator data

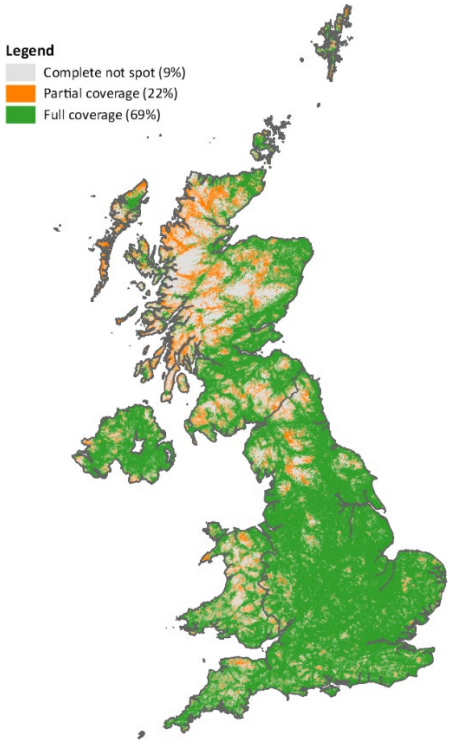
The Shared Rural Network (SRN) and other public policy interventions.

Ofcom is committed to reporting on progress made by the operators towards the legally binding commitments entered into their licences as part of the SRN. Under the agreement, each MNO is committed to reaching 88% coverage of UK landmass by 2024, and 90% of landmass within 6 years from 2020 (subject to certain conditions), with an expectation that this will see the 'at least one operator' footprint (i.e. the area where there is mobile coverage available, but not always from the same MNO) reach 95% of UK landmass by 2025.

[88] Scottish Natural Heritage (now NatureScot), Scottish Natural Heritage's Advice to Government, 16 June 2014

As noted above, MNOs have now moved into the detailed planning phase. In November, Ofcom wrote to the MNOs to confirm that in our view, the updated plans they have developed would, if delivered, meet the licence commitments.[89] As of today, only one operator (Vodafone in the villages of Longnor and Devauden in the Wye Valley) has informed us it has added 4G coverage through the programme.[90] An important focus for the SRN is the provision of new coverage in partial not spots, as part of the initial commitment for each MNO to reach 88% coverage by 2024. The potential impact of this can be seen from the current location of partial not spots in the UK today, as seen in figure 17 below.

Figure 17: full coverage, partial coverage and complete not spots in the UK



We expect to report on more significant progress as the programme moves into the delivery phase in the year ahead. We note that as well as the SRN, other public policy interventions continue to support the rollout of growth in rural mobile coverage. In particular, the Scottish Government's 4G Infill programme has begun to deliver, with more than 30 base stations in the build or pre-build stage, and one base station already live. These base stations, which will provide consumers with coverage in what were previously not spot areas, will complement the work of the SRN to improve mobile coverage in Scotland. Meanwhile, we note that other local authorities continue to plan and consider complementary interventions across the UK.

[89] DCMS, Press release: Shared Rural Network, 9 March 2020
[90] See stories on Shared Rural Network news page

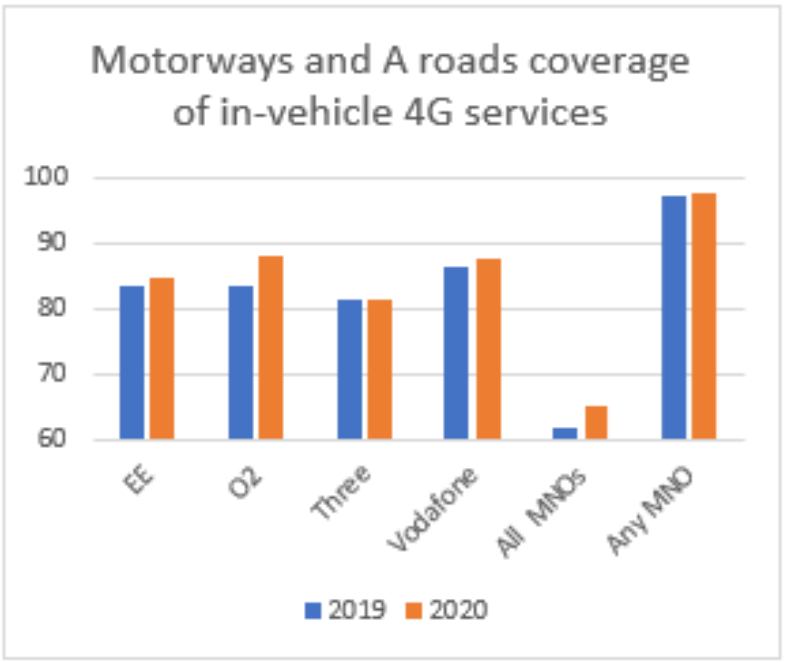
Coverage on roads

The need for connectivity to be available on all roads remains important to serve requirements such as vehicle communications, personal navigation, and infotainment. Over the past year, there has been very minimal improvement in mobile coverage from all operators on UK motorways and roads.

In-vehicle mobile voice services from all operators increased by at most 1 percentage point on UK motorways and A roads.[91] Today, mobile call services are available on 82% of UK motorways and A roads and on 69% of B roads. In 2017, Ofcom introduced regulations to enable the use of certain mobile repeaters on a licence exempt basis, which could help improve in vehicle reception to levels similar to those enjoyed outdoors.[92] Mobile voice services outside of vehicles is available on 96% of motorways and A roads and on 90% of B roads.

Within vehicles, 4G data coverage from all operators is available on 65% of motorways and A roads and 50% of B roads. Outside vehicles, 4G data services are available on 89% of motorways and A roads and 82% of B roads from all operators.

Figure 18: Motorways and A roads coverage of in-vehicle 4G services



Emergency calls

Mobile phones can use signals from other mobile networks to make emergency calls. As the mobile networks have slightly different coverage footprints, and voice calls can be carried over legacy 2G and 3G networks as well as 4G (via VoLTE), this means that 95% of the UK geographic area and almost all indoors premises are covered for mobile emergency calls. As we explain in the fixed and security and resilience chapters, traditional landline services are being retired and in future all fixed voice services will need to be delivered over broadband connections instead. Since this requires

[91] Note that we apply a 10 dB attenuation threshold to derive the availability of in vehicle coverage
[92] Ofcom, Mobile phone repeaters – what you need to know, 12 April 2018

power to the broadband router, indoor mobile coverage enabling emergency calls in a power cut may become increasingly important.

Within vehicles, mobile call coverage for emergency calls is available on 99% of motorways and A roads and 96% of B roads. Outside of vehicles, emergency mobile call services are available on almost all motorways and A roads and 99% of B roads.

Coverage for emergency mobile calls has not changed from last year.

2G/3G Switch off

Although MNOs have not publicly indicated firm timelines to switch-off their 2G or 3G networks, it is expected that factors such as operating costs and less efficient utilisation of spectrum for data services compared with newer generation technologies such as 4G and 5G may result in the eventual switch off of these networks.

Switching off these networks would impact a number of applications such as availability of mobile telephone calls, which rely either on these legacy services, or require Voice over Internet Protocol to be both available and supported by consumer devices. We note in particular that coverage for emergency voice calls, which today is primarily delivered over 2G and 3G, as well as other applications such as smart meters and e-call services, could be impacted without careful implementation.

Given that 4G is now at a level of maturity where it can outstrip the data carrying capability of 3G in most places, but that there remain a significant number of devices relying on earlier generation technology, we expect that typically 3G networks will be switched-off ahead of 2G networks.

It is important that as MNOs start to switch off these networks, adequate mitigation is in place to minimise the impact on consumers.[93]

Premises that do not have a decent fixed or 4G mobile network connection

As with last year, this report continues to examine those premises unable to get a decent fixed or 4G mobile broadband service. Premises are considered to have access to a decent fixed connection if the broadband speed is above a download speed of at least 10 Mbit/s and an upload speed of at least 1 Mbit/s and to have access to an indoor 4G mobile service if a connection speed of at least 2 Mbit/s is available.

We estimate that 98% of premises can receive both decent fixed and 4G mobile broadband services, while about 43,000 (0.1% of UK premises) are unable to access either.[94] As with last year, more premises currently have indoor 4G coverage from at least one operator than a decent fixed broadband service.

[93] Ofcom is committed to working with MNOs to minimise the impact of any 2G and 3G switch off plans on consumers.

[94] This includes premises that are unable to receive services from other providers such as Wireless Internet Providers (WISPs)

As with last year, rural areas in Scotland (particularly in the Scottish Highlands and Islands) and Wales have the highest percentage of properties that have neither decent fixed nor indoor 4G mobile services. These figures stand at 2% and 3% respectively.

Investment in mobile networks

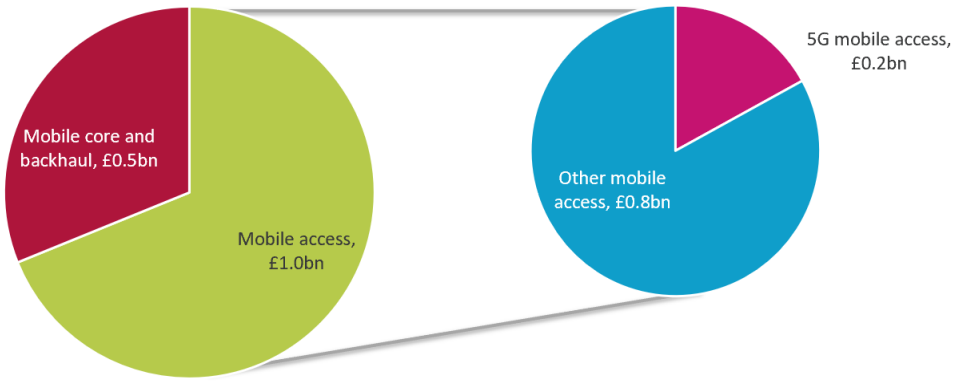
Around £1.5bn was invested in mobile network infrastructure in 2019

Ofcom data collected from providers shows that £1.5bn was invested in UK mobile network infrastructure in 2019, with an additional £0.7bn having been invested in infrastructure which is used to provide both fixed and mobile telecoms services.

Of the total mobile investment, around two thirds (£1.0bn) was investment in mobile access network infrastructure (including site acquisition, equipment and electronics), with the remaining £0.5bn spent on mobile core and backhaul networks. All four mobile network operators (MNOs) in the UK launched 5G services in 2019, when investment in 5G access networks totalled around £175m. We expect this figure will increase in 2020 as 5G rollout has gained momentum.

Further information on how these figures were compiled can be found in the fixed chapter, in footnote 45.

Figure 19: Mobile telecoms network capital expenditure: 2019



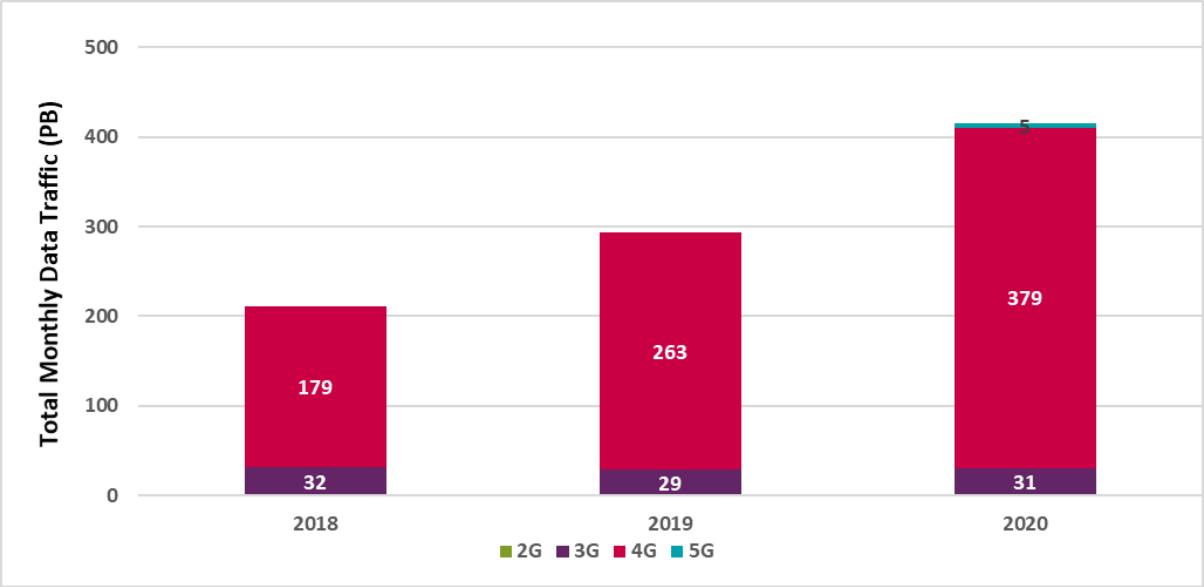
Source: Ofcom / operator data

Mobile network performance and capacity

Traffic continues to grow considerably, with 4G dominating

Mobile data traffic continues to grow significantly year-on-year. This year, our sample of monthly data consumption increased by 42% compared with last year, representing an increase of 8 percentage points in the year on year growth rate. Although operators now carry some data traffic on 5G (1% of the total mobile data traffic in 2020), 4G still carries the majority of overall data traffic. Traffic carried on 3G and 2G continues to fall in comparison with 4G, which now carries 91% of all traffic (up 1% on last year).

Figure 20: Mobile data traffic (PB) by technology (monthly consumption)[95]

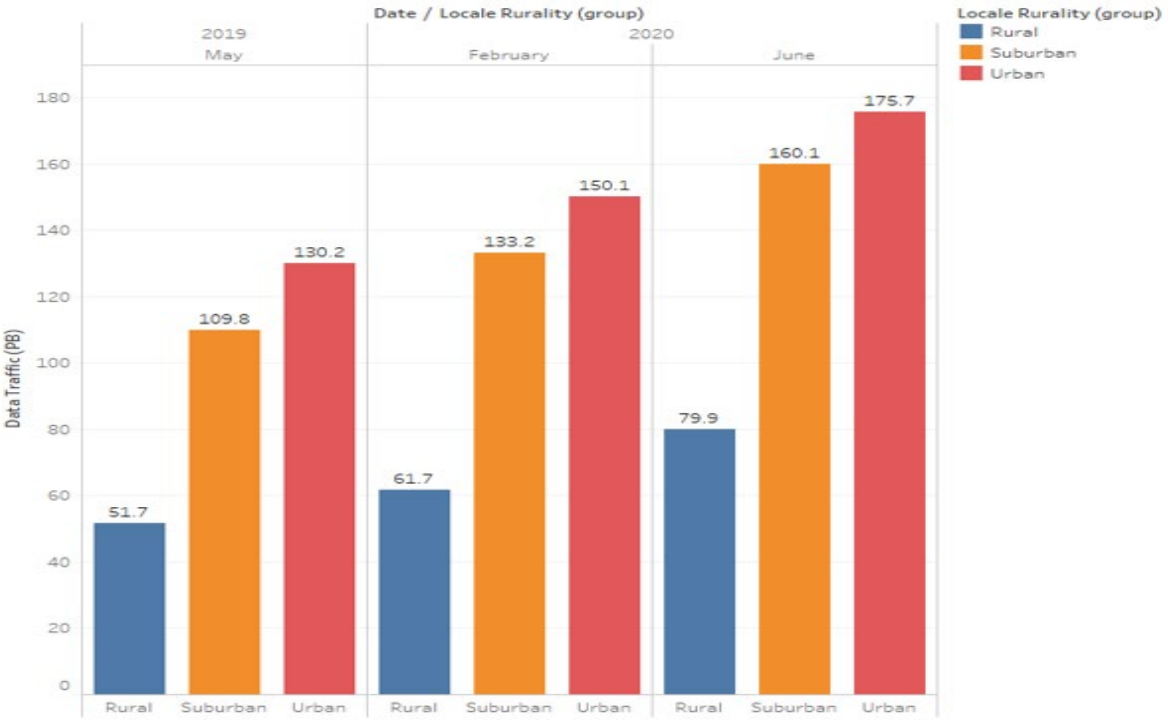


Source: Ofcom analysis of operator data

The vast majority of mobile data traffic (81%) is generated in urban and suburban areas, and data growth in these areas is continuing rapidly, up 40% compared with last year. We note that the difference to rural traffic consumption broadly reflects population distribution, rather than suggesting any fundamental differences in behaviour between customers based in urban and rural areas.

[95] This year's analysis is based on data collected for the month of June, with last year's sample collected in the month of May. Note that 1 Petabyte is equivalent to 1,000,000 Gigabytes

Figure 21: Evolution in Mobile Traffic by Rurality[96]

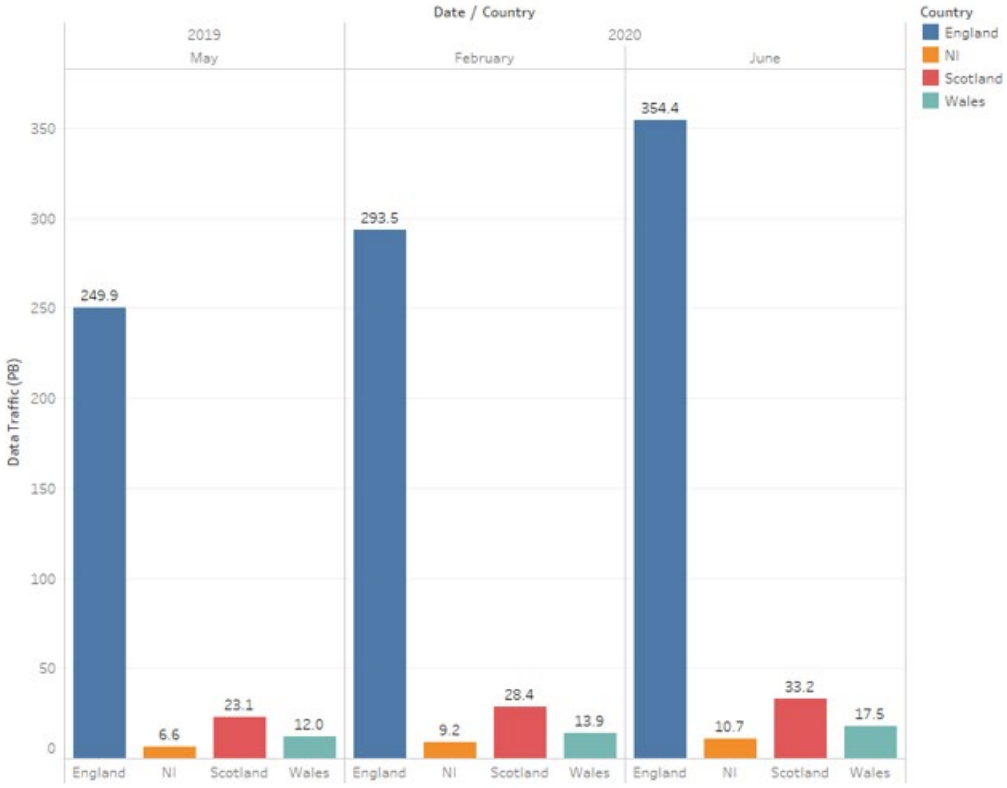


Rural mobile data consumption has also continued to grow year-on-year, increasing by 55% this year. However, this growth is from a relatively low base and represents only 19% of the total data traffic.

The essential link between population and traffic is also reflected in how traffic is distributed across the UK nations. The continuing growth in data consumption which is pushing ongoing spectrum requirements can be seen by the fact that the traffic carried in England in June of this year exceeds that which was carried across the UK as a whole in February.

[96] We note that traffic volumes were not supplied for the 3G layer of one MNO for 2020, and this may have some impact on year on year trend analysis.

Figure 22: Traffic distribution across the UK nations



We note that the preponderance of UK traffic carried by mobile base stations in different UK nations is broadly reflected in deployment trends for 5G base stations in each nation.

Internet of Things (IoT)

The Internet of Things (IoT) refers to a network of devices and sensors which provide actionable insight from data they collect and share between themselves or with humans. IoT has applications across a wide range of sectors such as healthcare, utilities, manufacturing, consumer electronics, and smart cities among others.

As with last year, we continue to provide qualitative and quantitative insights into public and private wide-area IoT networks in the UK. [97]

Low-power wide area networks (LPWANs)

- **Sigfox** is a proprietary technology that uses licence-exempt spectrum and offers good coverage with very low transmission power.
- **LoRaWAN**, developed by the non-profit LoRa Alliance, is an open source technology also using licence-exempt spectrum. It provides good coverage with very low transmission power and allows the building of an end-to-end private solution.

[97] We have found that mobile network operators generally do not differentiate between machine to machine (M2M) and IoT from a connectivity perspective and therefore we have included M2M data in our IoT analysis.

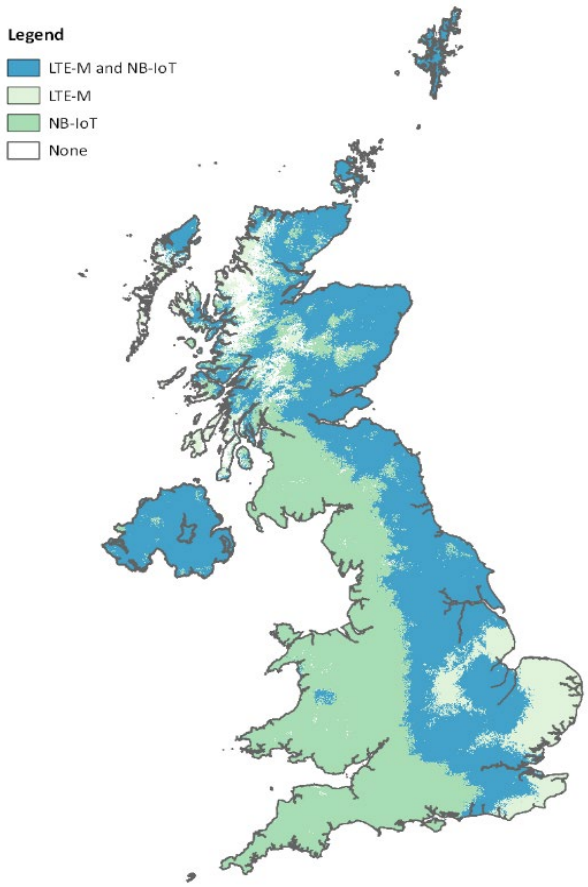
- **Narrowband IoT (NB IoT)** is a wide-area solution that supports massive deployment of IoT devices and is also optimised for a very long battery life. NB-IoT networks can be deployed in mobile bands and integrated on existing mobile base stations.
- **Long Term Evolution for Machines (LTE-M),** is a complementary technology to NB-IoT with the added capability of supporting IoT applications with higher data rates and lower latency requirements. It can also be deployed in mobile bands and integrated on existing mobile base stations.
- **NB-IoT** and **LTE-M** have been standardised by 3GPP and they are now part of the 4G standard. 3GPP is further evolving these technologies as a part of 5G. LPWAN technologies are designed for IoT applications and services that have low data rates, require long battery lives and can operate in remote and hard to reach locations

IoT Connectivity available from Mobile Network Operators

IoT connectivity is available from UK MNOs through a mix of cellular and Low Power Wide-Area-Network (LPWAN) technologies. Commercial IoT connectivity is available from all four UK MNOs through 2G, 3G, and 4G cellular technologies. Within the past year, Vodafone has increased the coverage of its NB-IoT network extending coverage to eastern parts of the UK. Whilst O2 has also deployed LTE-M at various locations across the UK, it is yet to offer commercial services using this technology. Three and EE continue to explore proof-of-concept deployments using NB-IoT, LTE-M and 5G.

This year, the number of active IoT connections on MNO networks increased by 30% to 6.3 million. However, at 810TB, the overall volume of IoT data traffic across all UK MNOs remains less than 1% of their overall data traffic. We note that this represents a snapshot of all IoT traffic, much of which is carried over Wi-Fi in indoor settings. We expect IoT data traffic to increase significantly with the availability of LTE-M and 5G both of which are capable of supporting higher bandwidth applications, such as video surveillance, compared with other IoT technologies.

Figure 23: Map of the UK showing LTE-M and NB-IoT Coverage



Source: Vodafone and O2

IoT Connectivity available from non-mobile network operators[98]

Sigfox

Within the past year, WND UK, the sole Sigfox network operator in the UK increased the number of its base stations from 1,900 to about 2,000. These improvements have focused on the provision of coverage overlays and densification of its urban footprints as well as deploying indoor solutions at locations not covered by the public network.

The network supports very low bandwidth applications with infrequent transmissions such as device telemetry, metering, asset tracking, gas and water leak detection.

LoRaWAN

In the UK, LoRaWAN connectivity is provided through public community and private deployments. The public community networks, which are open-source and free to use, allow users to connect devices to existing gateways (base station) or add new gateways to increase overall coverage. [99, 100]

[98] IoT can be delivered via other tech such as Wi-Fi, Zigbee, Bluetooth and several others. In this report, we focus only on LPWAN technologies.

[99] They are usually bound by fair use policies which restrict data rates, packet sizes, transmit time, number of gateways/devices, etc

[100] The network servers are hosted by not for profit institutions like the Digital Catapult (UK) or companies which also offer private networks.

These networks are collaborative and driven by the user community. The private networks offer managed carrier-grade services with guaranteed availability, on a paid basis.

Public LoRaWANs

Providers of public LoRaWANs allow users to connect freely (public 'open') or at minimal charges (public 'closed') thereby supporting developers, small/medium businesses and enterprises (particularly for Proof-of-Concept), government and public initiatives across the UK local authorities. Today, The Things Network (TTN), one of the leading (global) providers of public LoRaWANs has about 900 gateways in the UK (50% increase from last year) serving about 100 communities i.e. cities, counties or groups of hobbyists with deployments in close proximity.[101]

Private LoRaWANs

We are aware of several private LoRaWAN providers operating in the UK, such as Comms365, Connexion, The Things Industries (TTI), Boston Networks and Pinacl Solutions Limited[102]. We estimate that these networks have at least 350 gateways between them serving about 25,000 devices. Some of the services provided by these networks include intelligent lighting and property management, waste management solutions, flood and air quality monitoring.

[101] The Things Network

[102] Boston Networks and Pinacl Solutions Limited have now merged (and other businesses) to form North

Figure 24: Indicative map of locations in the UK where carrier-grade LoRaWAN Services are available[103]



IoT has played an important role during Covid-19

- IoT solutions have played significant roles in helping governments, businesses and the wider society meet the challenges of the Covid-19 pandemic. Several applications emerged which have helped minimise the spread of the disease such as: the NHS Covid-19 tracing app; drones for the delivery of medical supplies to remote locations; ensuring business continuity through the use of sensors for detecting desk/station occupancy, safe distancing and temperature detection; and in maintaining public safety through the use of drones for monitoring lockdown compliance.

[103] We note that LoRaWAN operates in an unlicensed spectrum band and there are several deployments which may not have been captured in the map. The locations shown represent providers who have provided us with this information. We will continue to collect data to populate this map.



Security and Networks

Key highlights:

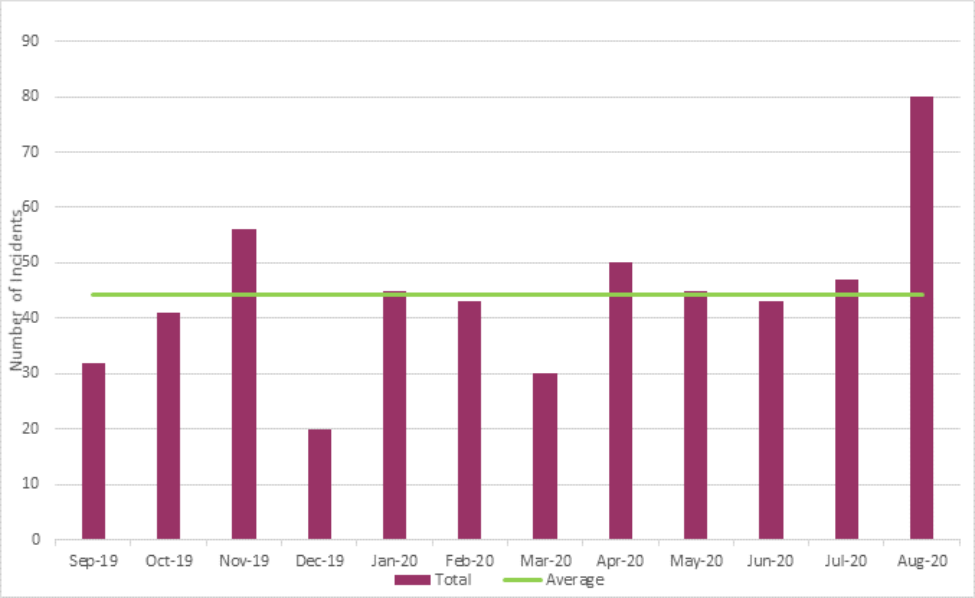
- The security incidents reported to Ofcom this year do not suggest that the Covid-19 pandemic has resulted in a noticeable increase in telecoms outages, despite the increased demands on the networks. One major incident affecting mobile phone users at the start of the first national lockdown does not appear to have reoccurred, but has led to some important lessons for the future.
- The work we started last year with telecoms providers to better understand the most common causes of major outages has identified several themes, and work to tackle these causes is ongoing.
- Ofcom has been working closely with DCMS and the National Cyber Security Centre (NCSC) in preparation for the introduction of the *Telecommunications (Security) Bill*, which will bring major changes to our existing regulatory regime.

Although slightly up on last year, the overall number of reported incidents is within the typical annual range

As in previous years, we have continued to receive reports from telecoms providers about any security incidents with a significant impact on their networks and services. We publish guidance for providers, explaining the types and sizes of incident we expect them to report to us in order to comply with their regulatory obligations.[104] We have received reports of a total of 532 relevant incidents this year. While this is a notable increase over the 410 incidents we reported in 2019, it is still within the usual year-on-year variability so does not raise any particular concerns. For example, we reported over 700 incidents in 2018. The number of incidents related to fixed networks is very similar to last year (283 in 2020 compared with 284 in 2019), which means that the increase in incidents reported to us resulted from mobile network incidents (249 in 2020 compared with 126 in 2019). As we have discussed in previous years, ensuring consistent reporting across mobile operators has been an ongoing challenge, and the increase we have reported in 2020 may to an extent be a reflection of progress in ensuring that more of the incidents occurring on mobile networks are properly reported to Ofcom.

[104] Ofcom, Ofcom guidance on security requirements in sections 105A to D of the Communications Act 2003, 18 December 2017

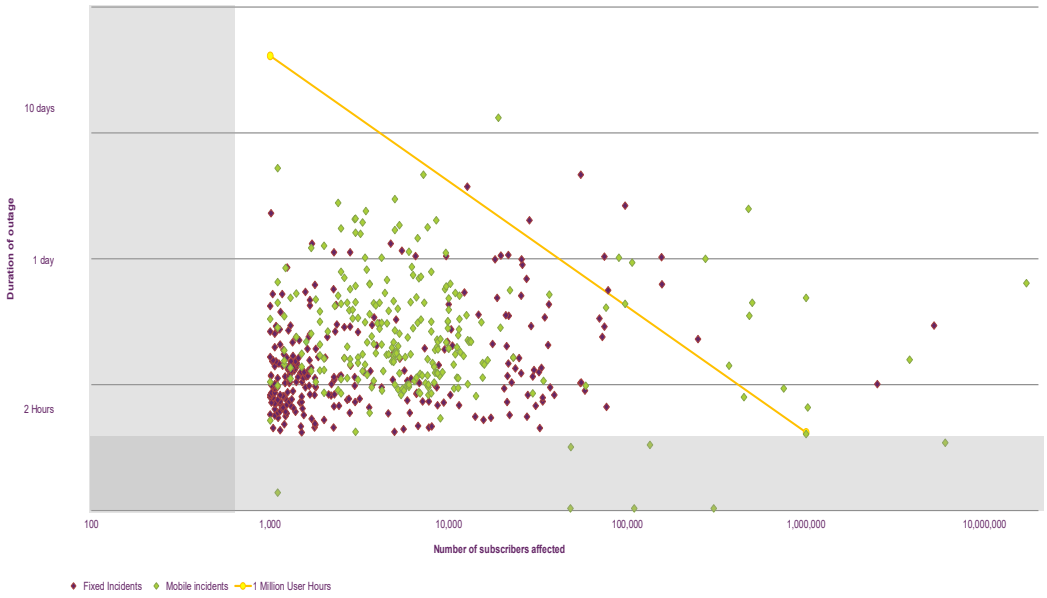
Figure 25: Monthly number of incidents reported between September 2019 and August 2020



Source: Ofcom analysis of operator reported data

The monthly breakdown of incidents in Figure 25 shows a degree of month-on-month variability which is somewhat higher than we have seen in recent years. As is usually the case, there are no obvious seasonal patterns. The average rate of incidents during the period of the Covid-19 pandemic is greater than it was for the period immediately before it. However, given the variability we see every year, the trend is not strong enough to suggest that the Covid-19 pandemic might have been the cause.

Figure 26: The impact of incidents reported between September 2019 and August 2020

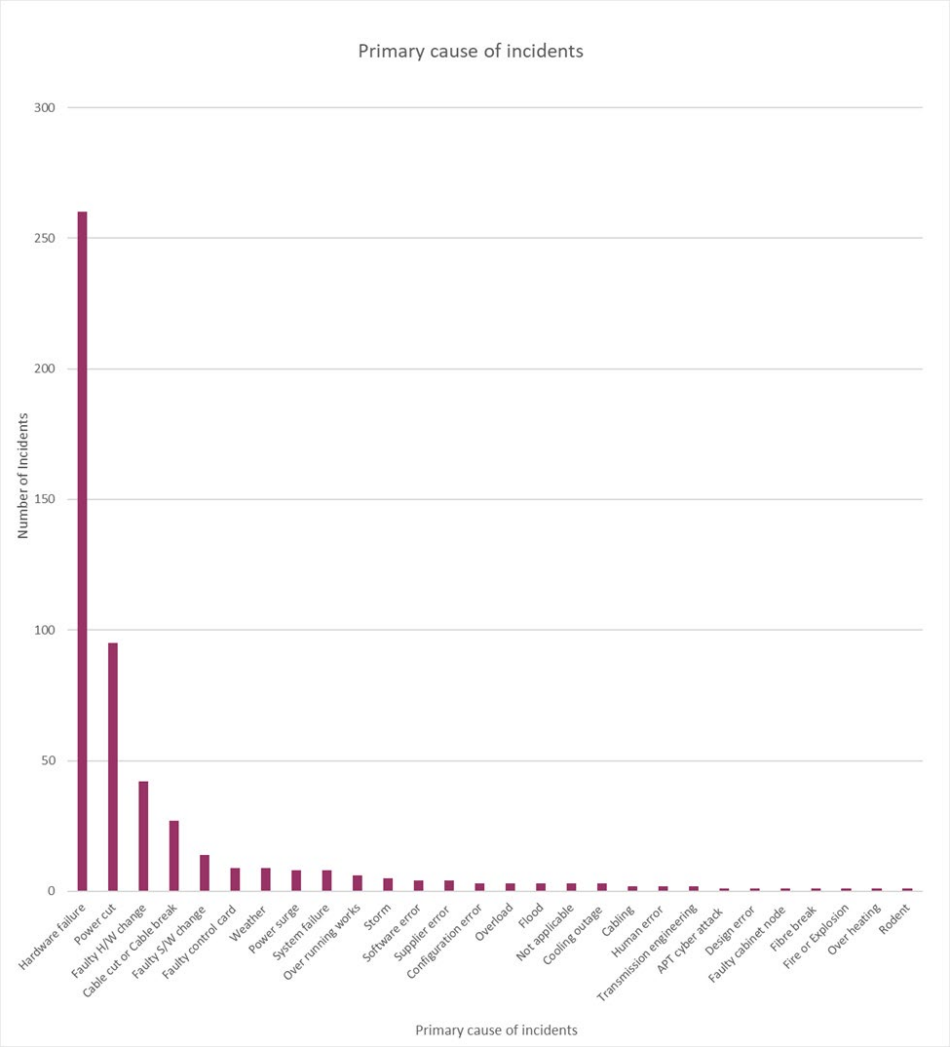


Source: Ofcom analysis of operator reported data

During this reporting period, we have changed the root cause categories we use to classify the primary cause of each incident based on the information in the providers' reports. This year we have assigned each incident to one of 28 possible root cause categories, whereas in previous years we have used only 12. This more granular approach allows us to better understand the common factors behind incidents. It also better aligns with the categories used by the European Network and Information Security Agency (ENISA) in its annual report on EU-wide trends.[105]

The most common causes of hardware failures and power cuts continue to dominate, as they have in previous years. One example of a new category - faulty hardware change - contains incidents which would have previously been most likely to appear in the broader hardware failures category. As such, the new categories now provide more insight into incidents caused by changes to hardware that a provider has made but have gone wrong, by separating them from the random in-life hardware failures that made up most of the original category.

Figure 27: Primary cause of incidents reported to Ofcom, September 2019 and August 2020



[105] ENISA, Telecoms Services Security Incidents 2019 Annual Analysis Report, 23 July 2020

Source: Ofcom analysis of operator reported data [106]

The geographic distribution of incidents is broadly in line with population density, with the heat map of incidents across the UK showing a similar pattern to previous years. There is no obvious evidence of a disproportionate number of incidents in rural areas.

Figure 28: Heat map showing the distribution of reported incidents throughout the UK



Source: Ofcom analysis of operator reported data

Networks have generally coped well with the increased demand placed on them during the Covid-19 pandemic, with limited evidence of additional outages

Our use of telecoms services has changed substantially due to the Covid-19 pandemic, and this has placed a considerable strain on many aspects of the networks. However, from the reports submitted to us, this has only caused one notable service outage. This incident affected customers on O2's mobile network in March 2020, just before the first national lockdown was announced and as many people started working from home. We have been working with the mobile network operators affected by the incident in order to fully understand the technical reasons for the incident and ensure the lessons learnt are incorporated into industry best practice. The following is a summary of the incident and the follow-up actions:

- there was a significant increase in mobile voice traffic in the run up to the first set of UK Government restrictions, with growth in both call volume and duration;

[106] H/W – Hardware, S/W – Software, APT – Advanced Persistent Threat

- this created a temporary congestion condition within the IP-based infrastructure used to interconnect traffic between a subset of mobile operators;
- this congestion was resolved by increasing the capacity of this infrastructure progressively over the following days;
- based on the technical findings, we are working with a number of operators to evaluate technical standards detailing how interconnect in IP networks should operate in such situations. We are considering both the applicability of existing standards and whether there is a need for an update or addition; and
- we are also considering the promotion of operational profiles for IP network interconnect and improved resilience to overload conditions.

Our work to better understand the common causes of network incidents has highlighted several resilience themes

To progress the UK Government's objective of an increased focus on the resilience of networks and services previously identified in the Supply Chain Review, we introduced in January 2020 an enhanced approach to information collection and analysis of service-affecting incidents. [107] We have worked with the telecom operator members of the Electronic Communications Resilience and Response Group (EC-RRG), who have provided the incident data. [108]

The purpose of this new approach is to increase the level of detail being supplied to us by operators in their incident reports. This additional detail enables us to undertake analysis of the root causes of incidents, and identify and understand any correlation between them, in greater depth than we have been able to in the past. This in turn adds significant value to the information and learnings that can be subsequently shared with operators.

The event correlation analysis conducted to date has produced a number of leading 'themes'. We will be working with respective communications providers to examine the root causes of these in further detail:

- **Change Management and Testing** - As communications providers have engaged in a number of network upgrade or transformation activities during 2020, we have seen multiple service affecting events caused by poor practice in change management and testing. In some examples, these events have not only caused extensive loss of service hours but have also been repeated within a change programme as it has progressed. Other examples have introduced single points of failure in the ability for consumers to access emergency services through implementation of a change followed by lack of adequate testing.
- **Backhaul Transport** - An analysis of incidents affecting backhaul transport in mobile networks appears to indicate a number of events where disruption at a single site caused the loss of service availability at a large number of additional sites. This indicates a dependency which in some cases impacts a significant volume of end users.

[107] DCMS, Notice: Telecoms Supply Chain Review, 8 November 2018
[108] Cabinet Office, Guidance: Telecoms resilience, 20 February 2013 (updated 5 December 2019)

- **Access & Aggregation** - An analysis of incidents within local access and aggregation networks that have occurred on a regular and sometimes frequent basis has indicated patterns within specific local areas that have been creating a cumulative impact on some consumers.
- **Interconnect** - the migration from the traditional PSTN towards IP networks and the progressive development of the alternative network service provider environment has increased the number of incidents affecting interconnect services.
- **Grey State** - Although not representing a large number of events, an increasing number of incidents have been recorded where resilience to equipment failure, being provided through the configuration of redundant nodes, has been unable to detect a trigger state such as the loss of a circuit and has therefore resulted in a single point of failure.

We have agreed with a number of operators that the analysis from our work on incidents can be anonymised, and a synthesis of causes and mitigation actions can be shared with other relevant operators.

Our analysis of reported incidents is supporting a number of other activities to improve resilience within the sector

We have helped to establish an operator Resilience Working Group within the EC-RRG through which the information and shared learnings from the enhanced approach described above can be used on a regular basis to provide updates for the EC-RRG Resilience Best Practice Guidance document. [109] [110]

Additionally, we are supporting the Resilience Working Group in the development of a Resilience Assessment Framework, that can employ the updated Resilience Best Practice Guidance to assist us and the communications provider community in the evaluation of future service affecting incidents.

Our work is also now extending beyond the large operators. This is important because the impending closure of the legacy Public Switched Telephone Network and evolution to all IP networks, together with the promotion of full fibre access networks, has created a vibrant eco-system of alternative network infrastructure and service providers.

We have already started to engage with these providers to advise them of their incident reporting obligations, and we will look to adapt and extend the work we are doing with the EC-RRG to ensure that the resilience capabilities of these networks also protect the availability of the services they provide to their customers.

Finally, the National Infrastructure Council (NIC) published in May 2020 its report and recommendations on the resilience of specific sectors that support critical national infrastructure. [111] We will be working with the UK Government where we can assist in its response to the NIC recommendations.

[109] Cabinet Office, Guidance: Telecoms resilience, 20 February 2013 (updated 5 December 2019)
[110] Cabinet Office, EC-RRG resilience guidelines for providers of critical national-telecommunications infrastructure
[111] National Infrastructure Commission, Resilience, 28 May 2020

There are important questions about how sufficient reliability will be delivered in the future

The telecoms sector is facing an unprecedented rate of change over the next five years or so. Some key underlying network technologies are being replaced; the range of services provided will evolve; and our reliance on these services in all aspects of our lives is rapidly increasing. It is vital that the new networks built during this period offer sufficient reliability to meet citizen and consumer needs.

A particularly important network technology change is the replacement of copper with fibre in the fixed access network. Fibre has made up the core of all networks for decades and has been gradually extending out towards customer houses and offices. Some customers already benefit from full fibre connections, but many more still rely on copper for at least part of their connection to the network.

As set out in the fixed broadband and voice section, there is another change to the technology that delivers basic phone calls over the fixed network. It is expected that by 2025, the PSTN will be switched off. Customers will still be able to make fixed line phone calls and for many, the experience and even the telephone that is used may not change. However, the technology will have changed, with these calls being carried over the broadband network. While this will bring many benefits, it will change some of the technical aspects of the service which determine its current levels of reliability.

One potentially negative impact of this change is on the ability of the future phone service to operate in the event of a power cut in a customer's home. Today, the traditional PSTN, when delivered over a copper connection, can use that copper to also deliver sufficient electricity to the home to power a basic wired handset. Most importantly, this means that if there is a power cut in the home, a customer can still use this handset to make an emergency call. This will no longer be the case after the PSTN and copper lines have been replaced. While contacting the emergency services may still be the single most "life or death" use of telecoms services, there are also other uses of the telecoms network that could be considered critical.

With so many more people and businesses relying on telecoms for such a range of different things of differing importance, it makes determining the optimum reliability of a given telecoms service very complex. This is particularly true when we consider that additional reliability often leads to additional cost, so these considerations involve a degree of trade-off with ensuring services are affordable.

Answering these questions requires careful consideration of the current and likely future uses of telecoms services. It also needs some coordination between all the networks that are being built now and in the coming years to ensure that the sector as a whole best delivers what the UK needs. This coordination is difficult for Ofcom or individual companies to achieve under the existing regulatory regime. It may instead require a government policy intervention, and consideration of whether the current regulatory regime can deliver any required changes in resilience and the associated investment.

Despite these challenges, there is much work underway. For example, as BT plans to replace the PSTN, it is consulting not only with its own retail division, but also with the many other telecom operators that rely on its network to sell services, to ensure the wide range of end customer needs are best met in the future. Also, as set out above, Ofcom is currently working closely with the EC-

RRG's industry members on a major update to its best practice guidance for members on building reliable networks. We are also drawing on the lessons we have learnt about the most common causes of network outages discussed earlier in this section.

New legislation next year will improve telecoms security and increase our role in monitoring and enforcement

Following on from the UK Government's Supply Chain Review, during the last year DCMS has developed new legislation to improve the security of the telecoms sector. [112] The *Telecommunications (Security) Bill* (the Bill) was introduced to Parliament in November. [113] It is expected to have implications not just for security, but also for the resilience of telecoms networks to certain types of service disruption.

The Bill changes the current telecoms security and resilience legislation in three main ways: [114]

- it imposes new, strengthened security duties on public telecoms providers, to be supported by detailed requirements in secondary legislation, and technical Codes of Practice giving guidance on the measures to be taken. The Bill also gives Ofcom powers to monitor and enforce industry compliance with these duties and specific security requirements, and to impose financial penalties in the event that we find a breach;
- it introduces new powers for the Secretary of State to set rules limiting the use of products and services provided by **High Risk Vendors (HRV)** where necessary in the interests of national security. [115] Although not involved in its enforcement, Ofcom may be asked to monitor public telecoms providers' HRV usage; and
- it implements some of the changes to the framework underpinning the existing legislation which were introduced in the **European Electronic Communications Code (EECC)**. These changes are relatively minor, and relate mainly to additional definitions to certain terms. [116]

[112] DCMS, Notice: Telecoms Supply Chain Review, 8 November 2018 (Last updated 22 July 2019)
[113] DCMS, Guidance: Telecommunications (Security) Bill: overarching documents, 28 November 2020
[114] Section 105A-D of the Communications Act 2003. More information can be found in Ofcom's guidance.
[115] High risk vendors are those that pose a higher security risk to the UK telecoms networks. For further details, please see: NSC, NCSC advice on the use of equipment from high risk vendors in UK telecoms networks, 28 January 2020 (reviewed 14 July 2020)
[116] DCMS, Government response to the public consultation on implementing the European Electronics Communications Code, 22 July 2020

Ofcom
making communications work
for everyone

Connected Nations 2021

UK Report



Strong, Secure Networks

Published 16 December 2021

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Overview

Ofcom's objectives include supporting investment in strong and secure networks, and getting everyone across the UK connected. In this annual Connected Nations report, we measure progress in the availability of broadband and mobile services in the UK, including the newest full fibre and 5G networks now being rolled out.[1] It also highlights the work we are doing, alongside UK and devolved governments and communications companies, to improve these services.

We have published separate reports on broadband and mobile availability in each of the UK's nations. Our interactive dashboard allows people to easily access data for different areas of the UK and specific types of services. We are also releasing the International Broadband Scorecard 2021, which compares the UK's recent position on broadband availability with a number of other European nations.

What we have found:

- **Full-fibre broadband is available to 8.2 million homes (28%).** This is 3 million more premises (10 percentage points) than a year ago, and represents the highest year-on-year increase since full fibre started being rolled out in the UK.
- **Gigabit-capable broadband is available to 13.7 million homes (47%).** This includes full-fibre and upgraded cable networks that are capable of delivering download speeds of 1 Gbit/s or higher.
- **The universal broadband service is helping some people in areas where decent broadband is not available**. Factoring in coverage from both fixed and fixed-wireless networks, we estimate that around 123,000 homes and businesses (0.4%) are still without access to a decent broadband connection. These properties may be eligible for a connection under the universal service.
- **5G rollout has continued at pace,** with the number of mobile base stations providing 5G services more than doubling over the last year, to over 6,500 sites across the UK**.** 87% of these are in England, 8% in Scotland, 3% in Wales and 2% Northern Ireland. We estimate that 5G is available from at least one mobile network operator (MNO) outside 42-57% of premises. [2]
- **Mobile coverage is generally stable.** The four Mobile Network Operators (MNOs) – EE, O2, Three and Vodafone – each estimate they provide 4G outdoor coverage to c.99% of premises. Networks' coverage of the UK landmass ranges from around 79% to around 86%. There has been

[1] This analysis is based on network availability data for September 2021. Since then, further rollouts will have occurred, including Virgin Media O2 announcing completing its upgrade to provide gigabit-capable broadband across its network. See Virgin Media O2, Virgin Media O2 completes gigabit upgrade in boost for Britain's broadband target [accessed 7 December 2021]. We estimate that this raises the gigabit capable coverage to over 60% for the UK. We shall provide confirmed figures in our Spring update.

[2] Mobile coverage statistics are based on signal strength predictions, and this estimate covers a range from a high to very high confidence of coverage.

some incremental progress in increasing coverage across each of the UK Nations by the MNOs, including 46 fresh deployments towards their Shared Rural Network commitments.

- **Networks have continued to perform well despite significant demands** as people and businesses relied on their phone and broadband connections during further periods of lockdowns due to the Covid-19 pandemic. Average monthly data usage on fixed networks has increased to 453GB from 429GB last year, and from 315GB in 2019. Whilst peak usage remains in the evening, networks continued to see high demand during the day due to continued working from home.

The UK continues to invest in faster, better networks

Full fibre and gigabit-capable broadband coverage is gathering pace

Coverage of faster, more reliable broadband services is improving across the UK.

Just over eight million (28%) UK homes now have access to full fibre connections – an increase of 10 percentage points or three million premises in the past year. This is the largest year-on-year increase in full fibre coverage that we have seen so far.

Gigabit-capable broadband – able to provide download speeds of 1Gbit/s or higher - can be delivered over full fibre networks and the latest versions of coaxial cable networks. Gigabit speeds are now available to 13.7 million (47%) homes. In most UK nations, gigabit-capable coverage is higher in urban areas than in rural ones. Full fibre and gigabit-capable availability is highest in urban areas in Northern Ireland, and lowest in rural areas of Scotland.

5G rollout is expanding

EE, O2, Three and Vodafone first started rolling out 5G in 2019 and have continued to extend their networks across the UK. 5G is estimated to be available from at least one operator outside 42-57% of UK premises. Some rollout is now extending into busy suburban areas and transport corridors, though most 5G sites continue to be added in busy urban areas and are providing additional capacity to existing mobile data services. 5G also offers new opportunities, including for the deployment of private networks, where we have seen further activity from both MNOs and other providers this year.

Good connections are available to most people across the UK

96% of UK premises have access to a superfast broadband connection with speeds of at least 30Mbit/s. Although most people have superfast broadband available to them, they do not always choose the fastest speeds. We estimate that around 69% of premises that are able to get superfast broadband actually take it.

Mobile operators provide a high level of 4G coverage outside of premises, with coverage from each mobile network in the vicinity of c.99% of premises. Indoor 4G coverage ranges between 90% and 95% of all premises. However, coverage levels remain lower in rural areas, and across the extent of the UK landmass. Individual operator geographic coverage ranges between 79% and 86%.

How Ofcom is supporting investment in new networks

Our aim is to support investment in the deployment of competing gigabit-capable networks to provide consumers with a choice of fast and high-quality services. We have put in place a regulatory framework for competition and investment for the five years to March 2026 to support this aim.

Rapid progress is being made in making full fibre and gigabit-capable services available. BT has committed to pass 25m homes with its full fibre network by 2026 and, since providing data to us for this report, Virgin Media O2 has said it has completed the upgrading of its existing coaxial cable network to enable gigabit-capable services across the whole of its footprint. At the same time, a large number of alternative network operators are deploying full fibre in local areas across the UK.

We are also supporting the rollout of new wireless services – including 5G. This includes making sure a diverse range of companies can access the spectrum they need to develop new services, bringing a better mobile experience to consumers and delivering economic benefits for the UK.

Ofcom is also working with UK and devolved governments to help improve access to mobile and broadband across the UK. Those governments are supporting rollout by investing public money in networks in areas which are unlikely to be covered commercially. We will work closely with the UK Government as it develops plans to invest in full fibre and gigabit-capable broadband through its UK Gigabit programme. We are also supporting programmes in the nations – Superfast Cymru in Wales, R100 and the Scottish Broadband Voucher Scheme in Scotland, and Project Stratum in Northern Ireland. Ofcom remains engaged in the development of the Shared Rural Network programme, which is seeking to expand the provision of mobile coverage across the UK. We will continue to report on progress before undertaking an initial compliance assessment against MNOs' 88% landmass coverage targets in 2024.

As the UK focuses on deploying new networks and moves away from the legacy fixed public switched telephone network (PSTN) and 3G (and eventually 2G) mobile networks, we are working closely with telecoms providers and other stakeholders to ensure a smooth transition and the ongoing support of vital services.

Some people are still struggling to get connected

A small – but significant – number of UK properties still cannot access decent broadband

Around 123,000 premises cannot get a decent broadband service of at least 10Mbit/s download speed and 1Mbit/s upload speed from either fixed or fixed wireless networks. These premises may be eligible to be connected under the universal broadband service.[3] Since its launch in March 2020, customers have placed over 1,300 orders for the universal service that will result in full fibre connections being available to almost 6,500 premises that previously had no access to decent broadband.

[3] Where the costs to provide the connection are below the cost threshold set by Parliament (£3,400), the customer can be provided a service at standard connection and rental charges without having to pay any additional installation charges. Where the cost of connection is above the cost threshold, these premises can still receive a service if the customer pays the additional costs.

We expect that many of the remaining premises will have to contribute to the costs of building a connection and, for a significant number of these, connection costs will be very high, which means they may not be able to gain decent broadband through the universal service scheme. We will work with the UK Government and industry to explore technology options and possible ways to fund providing connections to these properties, so they do not get left behind. This could include new wireless technologies and the latest generation of satellites which could offer good broadband services in rural areas not covered by other network deployments.

A small number of premises lack decent fixed broadband and 4G

We estimate that most UK premises can receive both decent fixed and good mobile services, but 38,000 (0.1%) cannot access either.[4] Providing connectivity to these premises is a particular challenge that we will discuss with government and industry when exploring how to connect the most remote premises across the UK.

The UK's networks have generally been resilient, while plans to further increase resilience, and greatly improve security, are underway

The network security and availability incidents reported to Ofcom this year show the pandemic did not result in a noticeable increase in telecoms outages, despite increased demands on the networks. The work we started last year with telecoms providers to better understand the most common causes of major outages has identified several themes, and work to tackle them is ongoing.

In this report, we highlight how software related failures have impacted on the scale and duration of reported incidents. Ofcom will continue to work with the networks, industry bodies and the UK Government to further improve network and service resilience.

Ofcom has also been working closely with the Department for Digital, Culture, Media and Sport, and the National Cyber Security Centre, in preparation for the Telecommunications (Security) Bill. The Bill has now become an Act, having received Royal Assent on 17 November 2021 and will impose new, strengthened security duties on public telecoms providers. The Act gives Ofcom extended powers and duties to monitor and enforce compliance against the obligations placed on telecoms providers.

[4] Premises are considered to have access to a decent fixed connection if the broadband speed is above a download speed of at least 10 Mbit/s and an upload speed of at least 1 Mbit/s and to have access to an indoor 4G mobile service if a connection speed of at least 2 Mbit/s is available.



Fixed broadband and voice

The importance of everyone having access to fast and reliable voice and broadband services, wherever they live and work, has continued to grow in 2021. The Covid-19 pandemic has meant people have continued to rely significantly on these services for work, education, healthcare and entertainment throughout the year.

Connectivity in the UK continues to improve, as existing networks are being upgraded and new fixed infrastructure is being built. We support the investment in full fibre and gigabit-capable networks – as do the UK and devolved governments – which give people fast, reliable and future-proofed connections.

Most homes and businesses benefit from a choice of broadband connections, which deliver superfast or higher speeds. But there are areas in the UK where faster services are not available yet. We remain concerned about the relatively small number of premises that still do not have access to decent broadband given the importance of connectivity to participating in an increasingly digital society. However, we note that this number continues to decline year-on-year.

For this report, we include data from over 40 full fibre communications providers and, for reporting on fixed wireless coverage, we have gathered, and include data from both mobile network operators (MNOs) and over 20 fixed wireless network operators.

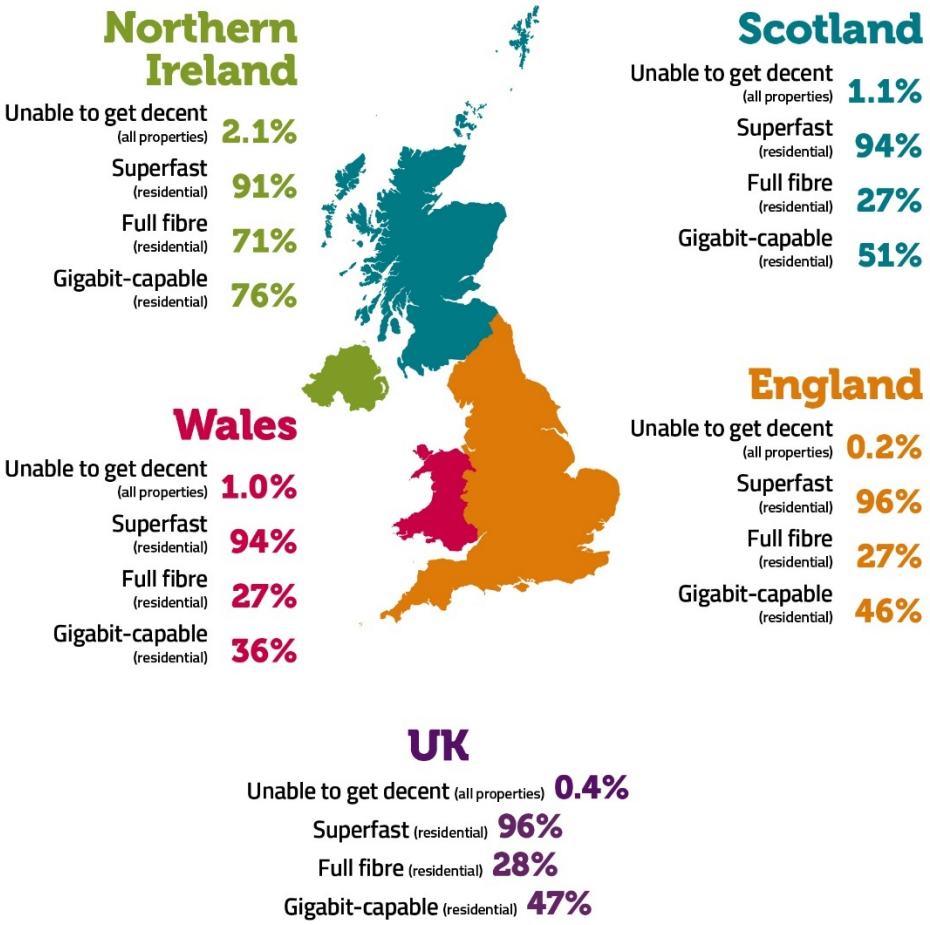
Key highlights:

- **Coverage of faster networks is increasing rapidly. Full fibre coverage is at 28% / 8.2m premises** – an increase of 10 percentage points / three million premises since our 2020 report. **Gigabit-capable coverage is at 47% / 13.7m premises** and we expected this will quickly increase further as Virgin Media O2 has announced it has completed the upgrade of its cable network.[5] **Superfast coverage remains at 96%.**

[5] Our coverage data was collected at September 2021. Virgin Media O2 announced it had completed its upgrade in December. Virgin Media O2 completes gigabit upgrade in boost for Britain's broadband target - Virgin Media O2 [accessed 7 December 2021]. We estimate that this raises the gigabit-capable coverage to over 60% for the UK. We shall provide confirmed figures in our Spring Update.

- Almost all **UK premises have access to a decent broadband connection.**[6] The number of premises without access to decent broadband has fallen further to around 0.4% / 123,000. Some of these 123,000 premises will be connected via publicly funded schemes in the next twelve months. We estimate this could leave around 100,000 premises. The **Broadband Universal Service Offer (USO)** will provide connections to some of these premises.
- Average monthly data use has continued to grow, and now stands at **453 GB per connection compared to 429 GB last year.**
- **Customers are upgrading to higher speeds and over two-thirds of consumers that have access to superfast broadband have upgraded to a superfast service.** We estimate that around 24% of premises with access to full fibre take a full fibre service, with take-up increasing by at least 750,000 premises since last year. And 69% of premises able to get superfast broadband actually take a superfast or faster service.

Summary of broadband coverage at a fixed location across the UK and Nations



[6] Unless otherwise specified, coverage figures for decent broadband count all UK premises (residential and commercial). Coverage for all other speed tiers counts residential premises only, unless otherwise specified.

In this section, we report on the following key areas of fixed connectivity:

- the rollout and upgrade of networks across the UK (including, a summary of investment in fixed networks);
- the deployment of fixed wireless and new satellite networks and how these help provide connectivity to decent broadband services;
- progress of the broadband USO, which launched in March 2020;
- the take-up of different broadband services;
- the data customers are using over these services; and
- environmental sustainability.

Throughout this section we generally report data for residential premises unless stated otherwise. However, for reporting of premises not able to get decent broadband which may be eligible for the USO, we report all premises. This year we have also introduced a short section setting out the coverage available to small and medium sized enterprises (SMEs).

A variety of fixed broadband networks and services are available in the UK

Fixed broadband in the UK is available at a variety of speeds, delivered over different technologies

Different technologies used to deliver fixed broadband connections

- **Copper (ADSL)** [7] **–** Copper cables are used to connect from the exchange to the premises (also known as 'standard broadband'). Maximum download speed is up to 24 Mbit/s. Actual speeds delivered by copper connections diminish with distance. Copper can also be affected by poor weather. Since the copper network is old, it can be susceptible to faults.

- **Fibre to the cabinet (FTTC)** – Fibre to the cabinet, with copper cables used to connect from the cabinet to the premises. FTTC uses very high-speed digital subscriber line (VDSL) technology. Maximum download speed is up to 80 Mbit/s (except for G.fast). [8] As with ADSL, actual speeds diminish with distance, and the network can be affected by poor weather and is susceptible to faults.

- **Hybrid fibre coaxial cable (HFC)** – The cable TV network.[9] It uses fibre to a street cabinet and coaxial cable from the street cabinet to the premises. There is decreased signal loss compared to the copper network as described above, which means co-axial cables are capable of delivering much higher speeds. Broadband is supported using the DOCSIS standard, which shares the capacity downstream and upstream between multiple customers.[10] The latest standard of cable

[7] ADSL: Asymmetric Digital Subscriber Line.
[8] Openreach deploys G.fast at some cabinets. It uses fibre to the cabinet, and copper from the cabinet to the customer. By using a higher frequency signal on the connection to the customer, G.fast can offer higher speeds than normal FTTC deployment, with Openreach offering wholesale services at up to 330 Mbit/s. But the signal degrades more quickly so the customers able to get ultrafast speeds are limited to those closest to the cabinet.
[9] Most cable broadband in the UK is provided by Virgin Media O2.
[10] DOCSIS: Data Over Cable Service Interface Specification.

technology, DOCSIS 3.1, is capable of delivering download speeds of up to 10Gbit/s and upload speeds of up to 1Gbit/s, although in practice speeds average out significantly below this – and since capacity is shared among users, it may not be the case that each user can simultaneously receive gigabit speeds. Depending on the configuration of the access network in any particular area, this can lead to localised congestion. This may be particularly acute in the upstream direction where total capacity is more limited.[11]

- **Full fibre or 'fibre to the premises' (FTTP) –** The connection from the exchange to the premises is provided entirely over optical fibre. Generally, distance to the premises does not affect the speed delivered. Full fibre is less susceptible to faults and is not usually impacted by poor weather. Most full fibre implementations utilise Passive Optical Network (PON) approaches where capacity in the downstream and upstream direction is shared.[12] The number of customers connected to each shared PON is usually 32 or less, which is generally fewer than shared infrastructure on a cable network. This, along with managing the maximum guaranteed throughput provided to each customer, can be used to manage congestion. PON technology has an upgrade path that allows for speed to increase from a shared 2.5 Gbit/s down/1 Gbit/s up to 10 Gbit/s in both directions, and future generations will expand this further.

- F**ixed Wireless Access (FWA) via mobile networks:** Fixed wireless access on mobile networks is offered on licensed 4G and 5G networks, usually to an indoor router. These services share the network capacity with mobile users, meaning that the capacity of the network has to be carefully managed between the demands of existing mobile users and FWA customers. There may be areas of high mobile demand where a reliable FWA service cannot be offered.

- **Fixed Wireless Access via Wireless ISPs (WISPs**): The majority of these services are delivered over wireless networks that communicate via a wireless link between a provider's mast site and an external antenna fixed to a customer's premise. These networks generally use license exempt or lightly licensed spectrum. Due to the frequencies where this spectrum is available, performance may be limited by line-of-sight issues.

[11] Virgin Media O2 has announced its plan is to upgrade its cable network to full fibre to deliver further enhancements to services. Q2 2021 Earnings Release (virginmediao2.co.uk)

[12] Virgin Media O2 is also deploying some full fibre networks as part of its network expansion. Currently this uses a technology called Radio Frequency Over Glass (RFOG) which allows the DOCSIS signals to be carried over fibre end-to-end. This deployment is capable of also supporting PON technologies and Virgin Media O2 are now trialling the use of XGS-PON with the intention of using this to replace both RFOG and HFC during this decade. Virgin Media O2 UK Update on Wholesale and FTTP Upgrade Plan - ISPreview UK

Figure 1: Summary of characteristics of different types of fixed broadband

Type of broadband[13]	Speed	Use cases	Fixed broadband technologies that can provide this service
Decent[14]	10 Mbit/s download; 1 Mbit/s upload	Making a high definition video call using applications like Zoom, Teams, WhatsApp or Facetime. Downloading a 1 hour HD TV episode (1GB) in almost a quarter of an hour.	Copper (ADSL) FTTC (VDSL) HFC Cable Full Fibre
Superfast	At least 30 Mbit/s download	One person streaming 4K/UHD video. Downloading 1 hour HD TV episode in under 4 and half minutes. Several devices working simultaneously.	FTTC (VDSL) HFC Cable Full Fibre
Gigabit	1 Gbit/s and above download	It is feasible to download a full 4K film (100GB) in under 15mins. May be delivered over technologies that give greater reliability and that are future proofed as more high demand services are developed.	HFC Cable (when upgraded to DOCSIS3.1) Full Fibre

FWA (both that provided by MNOs and by WISPs) can also provide decent, superfast and gigabit speeds, but this will be dependent on the specific deployment, available capacity at the site, and the number and location of users.

Fixed broadband coverage has continued to increase across the UK

Full-fibre broadband is now available to 28% of premises, with gigabit-capable broadband available to 47%

Full-fibre (FTTP) broadband is now available at 28% / 8.2m premises

Our data shows that 28% / 8.2m residential premises in the UK are now served by full fibre – an increase of 10 percentage points, representing over three million additional premises, in the past year. This year we have increased the number of fibre network providers that we gather data from. The new providers we have included tend to be smaller and often target rollout in less well served areas. As such they do not necessarily significantly alter the national figures, but they are important in providing full fibre coverage at the local level. The big increase in national coverage is largely due

[13] In previous years we have reported on ultrafast broadband as well. Ultrafast is broadband at speeds of 300Mbit/s and above. As network rollout focuses on full fibre and Virgin Media O2 has completed its upgrade of its cable network to DOCSIS3.1, we have focused this year on gigabit speeds (and gigabit capable networks). We have removed ultrafast broadband from our main reporting, although the numbers are still available in the interactive report.

[14] The UK government defines a decent broadband service as one that delivers at least 10 Mbit/s download speed and 1 Mbit/s upload speed. This is the level of connection deemed necessary for consumers to participate in a digital society.

to the continued investment in the rollout of fibre networks in the UK from providers planning wider geographic coverage, such as Openreach, Virgin Media O2 and CityFibre.[15]

Gigabit-capable broadband is now available at 47% / 13.7m premises

As shown in Figure 2 below, when all technologies are combined, our data shows that 47% / 13.7m residential premises now have access to gigabit-capable broadband. Some of these premises have access to more than one gigabit-capable network: around 7% / 2 million residential premises have access to a gigabit-capable broadband service over both cable and full-fibre technology, and 3% / 870,000 have a choice of two (or more) full fibre networks.

Figure 2: Residential full fibre and gigabit-capable coverage

	Full Fibre	Urban	Rural	Gigabit capable	Urban	Rural
England	27% (6.5m)	27% (5.7m)	25% (0.8m)	46% (11.3m)	49% (10.5m)	26% (0.8m)
Northern Ireland	71% (0.5m)	85% (0.5m)	36% (0.1m)	76% (0.6m)	92% (0.5m)	36% (0.1m)
Scotland	27% (0.7m)	30% (0.6m)	17% (0.1m)	51% (1.3m)	58% (1.3m)	18% (0.1m)
Wales	27% (0.4m)	29% (0.3m)	24% (0.1m)	36% (0.5m)	39% (0.4m)	24% (0.1m)
UK	28% (8.2m)	28% (7.2m)	24% (1.0m)	47% (13.7m)	50% (12.7m)	25% (1.0m)

Source: Ofcom analysis of provider data.

In the last year, across the UK, full fibre rollout has increased by ten percentage points. The largest percentage increase has been in Northern Ireland. There has been rollout in both urban and rural areas, but urban areas continue to have greater access to full fibre.

Gigabit-capable coverage has increased by twenty percentage points to 47%. In addition to full fibre, Virgin Media O2's upgrade to DOCSIS3.1 is a key driver of this increase. This means that whilst there has been an increase in gigabit capable coverage in both urban and rural areas, there has been a greater increase in urban areas.

Rollout of full fibre and gigabit-capable networks

Significant progress has been made over the past year in the roll-out of full fibre and gigabit-capable networks. We expect availability of these networks to continue to increase in the coming years. Different providers are taking different approaches to their business models for deploying these networks:

- Openreach is the incumbent wholesale infrastructure provider for almost all of the UK.[16] It has the largest network and connects the most premises. It plans to reach 25 million

[15] Virgin Media O2 has rolled out full fibre to a significant number of premises under Project Lightning.
[16] KCOM is the incumbent in and around the city of Kingston upon Hull. KCOM committed to full fibre deployment a number of years ago and availability is approaching 100%. KCOM is also extending its full fibre footprint beyond its traditional area of operation.

premises with full fibre by December 2026.[17] This includes 6 million homes in harder to reach areas by 2025/26.[18]

- Virgin Media O2 has announced it has completed upgrading its cable network, bringing 'gigabit speeds' to over 15 million premises.[19] This should be reflected in our first update in 2022, after which we would then expect to see further increases being driven by full fibre deployment with the gap between full fibre and gigabit-capable coverage reducing in future.
- CityFibre plans to pass 'up to 8 million premises' (both residential and business) across 285 towns and cities by 2025.[20]
- Some providers, like Hyperoptic and Community Fibre, focus on connecting premises in urban areas, while Gigaclear, B4RN and a number of others focus on connecting more rural areas. There are a range of approaches taken by these providers. Some work closely with local communities to determine areas with demand, and may include the local community undertaking some of the work. Others plan their own commercial builds in areas they assess as less well served by providers such as Openreach. Some may also bid for public funding to support rollout. Providers may follow one of these approaches, or a combination of them.

Deploying these new networks requires significant investment and engineering resources. The cost and timeframes for deployment can be reduced if a provider can roll out its network by using Openreach's c.470,000km of duct and c.4,000,000 poles. From April 2021, our Wholesale Fixed Telecoms Market Review put in place rules to allow easier access to Openreach's physical infrastructure (PIA).[21] As at the end of September 2021, 134 providers had registered with Openreach as customers of PIA, and over 80% have already built network using PIA or have placed orders to do so. Providers have ordered c. 53,000km of duct (8,000km of which has been delivered) and c. 405,000 poles (33,000 of which have been delivered) to deploy networks.

The UK Government has been working with industry and other stakeholders to ensure that the process for installing full fibre in new-build and multi-dwelling units is simplified. Alongside this, Government has also been working to reduce the administrative burden required when agreeing access to private land. This has led to proposed changes to legislation through the Product Security and Telecommunications Infrastructure Bill (PSTI).[22] Progress has been made in bringing together site providers and their representatives with telecoms providers building new infrastructure. However, there remain significant challenges, not least balancing between site providers' and telecoms providers' rights. In addition, the process of agreeing site access and information sharing between parties to ensure each can discharge their responsibilities to an acceptable standard will in the future need to take account of the provisions in the building safety bill which is currently progressing through parliament.[23]

[17] BT Group press release, 13 May 2021 [accessed 22 October 2021].
[18] Openreach press release, 28 May 2021 [accessed 22 October 2021].
[19] Virgin Media O2 press release, 7 December 2021 [accessed 7 December 2021].
[20] CityFibre press release, 3 November 2021 [accessed 8 November 2021].
[21] Ofcom, Wholesale Fixed Telecoms Market Review Statement, 18 March 2021.
[22] The Product Security and Telecommunications Infrastructure (PSTI) Bill - factsheets - GOV.UK (www.gov.uk) [assessed 9 December 2021]
[23] The Building Safety Bill

We will collect and report on future network deployments as part of our Connected Nations reporting

Following the revision of the Communications Act 2003 in December 2020, Ofcom is required to collect proposals for future network deployments from telecoms providers, in addition to information on existing networks that is already used to inform our Connected Nations reports.[24] The process of collecting this information is now in progress with the first results and insights derived expected to be published in 2022 as a supplemental annex to this report.

Most homes in the UK have access to a superfast broadband connection

Superfast broadband is available to 96% / 28.1m of UK premises, an increase of 275,000 over the year.

Figure 3: Residential superfast coverage

	Superfast	Urban	Rural
England	96%	98%	85%
Northern Ireland	91%	99%	70%
Scotland	94%	98%	73%
Wales	94%	98%	80%
UK	96%	98%	83%

Source: Ofcom analysis of provider data.

There will continue to be investment in superfast broadband networks, mainly due to publicly funded rollout under a number of schemes (described below). However, investment is now heavily focused on deploying gigabit-capable networks and in future will mainly deliver increased availability of full fibre. As such, we expect future increases in superfast broadband coverage to be modest.

[24] s.134B(1)(j) Communications Act 2003 was added by The Electronic Communications and Wireless Telegraphy (Amendment) (European Electronic Communications Code and EU Exit) Regulations 2020 (S.I. 2020/1419). This requires Ofcom to collect any proposals within the next 3 years to bring into operation a new very high capacity network, other than a mobile network or extend or upgrade any part of a fixed line network or its equivalent in order to provide a download speed of at least 100 Mbit per second.

Small and medium sized enterprises have good access to full fibre, gigabit capable and superfast broadband, but availability lags behind that for residential premises

Our reporting above on the availability of full fibre, gigabit capable and superfast broadband reflects the coverage of residential premises. But access to these services is also vital to businesses across the UK, and so this year we are also reporting on coverage for businesses.[25]

Figure 4: Business broadband coverage

Size of business premises	Superfast broadband availability	Full fibre availability	Gigabit capable availability
Micro (1 – 9 employees on site)	93%	26%	46%
Small (10 – 49 employees on site)	89%	23%	36%
Medium (50 – 249 employees on site)	85%	21%	33%

Source: Ofcom analysis of provider and business data.

We note that availability of full fibre, gigabit capable and superfast broadband networks is lower for small and medium enterprise business locations than for residential premises. Micro business sites, which make up around 90% of all business premises in our analysis, have the highest coverage. This may be because micro-business premises are often located in residential premises, or in residential areas and can make use of residential services.

Whilst coverage is lower for larger business sites, our network coverage data does not include networks deployed specifically to connect businesses (in particular, we do not gather data on leased lines specific networks), and so these sites may be able to get good connectivity, albeit via leased lines rather than broadband products.

By nation, England has the greatest availability of superfast broadband for SMEs, whilst Northern Ireland has the most coverage of full fibre and gigabit capable. As for residential premises, coverage of superfast, full fibre and gigabit capable is generally better in urban areas than in rural areas.

Figure 5: Business broadband coverage by nation

	Superfast broadband			Full fibre			Gigabit capable		
	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
England	**94%**	95%	79%	**25%**	24%	26%	**45%**	48%	27%
Northern Ireland	**84%**	95%	62%	**55%**	69%	28%	**60%**	78%	28%
Scotland	**89%**	95%	64%	**23%**	24%	14%	**44%**	50%	15%
Wales	**89%**	96%	70%	**27%**	27%	26%	**34%**	37%	26%

Source: Ofcom analysis of provider and business data.

[25] We have used a database of business premises, matched to our premises database, for this analysis. Our reporting is based on the size of the business premises (so, for example, small outlets of high street retailers are included even though the business is considered a large business overall). Our methodology explains the approach in further detail.

Decent broadband over a fixed connection is available to almost all homes and businesses

Taking into account all fixed line connections (but excluding FWA coverage), 98% of UK homes and businesses have access to at least decent broadband, the same percentage as in 2020. Around 651,000 premises do not have access to decent broadband via a fixed connection. This shows a slight increase from our report last year. As explained in our spring 2021 update, this is due to a small change in our methodology.[26]

Figure 6: Premises unable to receive decent broadband from a fixed line

	Total	Urban	Rural
England	2% (451,000)	1% (217,000)	7% (234,000)
Northern Ireland	6% (45,000)	1% (6,000)	17% (39,000)
Scotland	4% (100,000)	1% (13,000)	17% (87,000)
Wales	4% (55,000)	1% (11,000)	12% (43,000)
UK	2% (651,000)	1% (248,000)	9% (403,000)

Source: Ofcom analysis of operator data.

Specifically for small and medium sized enterprises, coverage of decent broadband from fixed networks is lower than generally across all residential and business premises as shown above:[27]

Figure 7: Business premises unable to receive decent broadband from a fixed line

Size of business premises	Total	Urban	Rural
Micro (1 – 9 employees on site)	3%	1%	12%
Small (10 – 49 employees on site)	4%	3%	12%
Medium (50 – 249 employees on site)	6%	4%	15%

Source: Ofcom analysis of provider and business data.

[26] In our Spring 2021 update, we refined the way that these properties are identified and 'address-matched' to operator data to more precisely provide estimated speed data for individual apartments and similar premises. Previously we had included premises in our figures where we had no operator coverage data but they were closely associated with adjacent properties. We have since refined the way that these properties are identified and 'address-matched' to operator data to more precisely provide estimated speed data for individual apartments and similar premises. In doing so, the number of properties for which we have no operator data increases, which results in the higher figure given here. See also footnote 4 in our Connected Nations Spring Update 2021.

[27] As noted above, some business premises (particularly larger premises) may be able to be served by leased lines networks which are not included in our coverage data.

Broadband services are also available across large parts of the UK using wireless networks

Fixed Wireless Access on mobile networks

Of the four MNOs in the UK, only O2 does not currently offer FWA services. Based on the MNOs' claimed coverage, we estimate that 94% of UK premises have access to an MNO FWA service.[28] MNOs claim average download speeds up to 100-200Mbit/s on their 5G FWA services. Download speeds on 4G FWA are lower.

These services are provided to an indoor router, although EE offers an external antenna for its FWA services in areas with poor indoor coverage. The end users' experience of the service could be affected by where they place the router, their indoor mobile coverage, the capacity available in the wireless access network and the backhaul network, and the number of users at that location.[29]

Based on the data provided by the MNOs, 88% of mobile FWA customers have access to a 4G FWA device compared to 11% who have access to a 5G FWA router.[30]

Fixed wireless access from WISPs

This year, we have expanded our collection of WISP coverage data; asking operators to provide their own estimate of coverage, factoring in network capacity constraints, interference and other external factors.[31] Based on providers' estimates, over two million homes and businesses have coverage from a WISP network.[32] As with FWA provided by MNOs, localised issues may mean a particular premise may not be able to receive a service despite being predicted to do so. These services are primarily delivered using licence-exempt spectrum in the 5GHz band.

We have carried out some research this year, looking into the speeds that can be delivered to consumers using WISP networks. We have a long-established programme on home broadband performance research on fixed networks,[33] and using the same approach, we conducted measurements on five WISP networks. Our results show that WISP networks are capable of delivering decent and superfast speeds.[34]

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[28] This estimated coverage figure is based on coverage data provided by EE and Three. While Vodafone provides an FWA service across its mobile network, we do not have data at the level of granularity needed to map its coverage to UK premises and so it is not included in this figure. More generally, coverage forecasts are determined by predictive modelling tools, localised issues may mean that particular premises may not be able to receive a service despite being predicted to do so.

[29] Backhaul here refers to the connection between the cell site and the mobile network core.

[30] Consumers with a 5G FWA device but who cannot receive a 5G signal would be served by a 4G network where there is coverage.

[31] Previously, we have rolled over coverage data where WISPs have not provided updates. This year we have issued a new request to WISPs for an updated set of information about their network and have not rolled over submissions based on our previous requests. Therefore, our coverage estimates are not comparable to those reported in previous years. See our methodology for more information.

[32] The number of premises covered by a WISP is up by more than 600,000 on last year but as noted in the previous footnote, a change in methodology means the figures are not directly comparable.

[33] This research uses a panel of consumers, who have a monitoring unit connected to their broadband router. This measures the performance of the home broadband services, including metrics such as download and upload speeds, latency, jitter and packet loss.

[34] See our interactive report for more information.

Fixed Wireless Access delivered by WISPs can be used to provide gigabit speeds using spectrum in higher frequency bands. Some WISPs are beginning to offer these services, but it has not yet been very widely deployed, due to the high cost of equipment. Over the next year, we will continue to work with FWA providers to understand how they manage the capacity of their networks and the performance of these services.

Figure 8: Coverage of MNO and WISP FWA networks with at least decent broadband

	MNO FWA	WISP FWA
England	94%	6%
Northern Ireland	82%	3%
Scotland	93%	2%
Wales	91%	31%
UK	94%	7%

Source: Ofcom analysis of provider data.

FWA and the impact on the availability of decent broadband

As shown in our research, both MNOs and WISPs networks can deliver a decent broadband service and can be an alternative network technology for consumers who cannot receive a decent broadband connection from their fixed network.

Based on the coverage estimates provided by FWA providers, we estimate that 528,000 premises that do not have access to a decent broadband service from a fixed network could have access via a FWA network. Some premises that can get decent broadband on a WISP network may also be covered by an MNO FWA service. Figure 9 below shows, by nation, premises without access to decent broadband from a fixed network, of these, which have access to decent broadband from only an FWA network, and, as a result, those remaining with no access to decent broadband from either fixed or FWA.

Figure 9: Access to a decent broadband service by different types of technology

	Has no access to decent broadband from a fixed network	Has access to decent broadband from an FWA network	Remaining premises without access to decent broadband
England	451,000	390,000	61,000
Northern Ireland	45,000	28,000	17,000
Scotland	100,000	70,000	30,000
Wales	55,000	40,000	15,000
UK	651,000	528,000	123,000

Source: Ofcom analysis of operator data.

A small – but nevertheless important – subset of UK premises still cannot access decent broadband

Our latest estimate is that around 0.4% / 123,000 premises in the UK still do not have access to a decent broadband service via either a fixed or fixed wireless network. This figure has reduced from around 190,000 last year, which we believe is due to a combination of factors, including that we have gathered data from more small fibre networks and FWA providers and because of some providers using more up to date premises data to report their coverage.[35] Some of the 123,000 premises will be due to receive a decent broadband service under a publicly funded scheme within the next 12 months. Based on data we gathered on public schemes, we expect this will leave around 100,000 premises without decent broadband. We discuss these schemes below.

We also note that modelling by BT based on data from our report last year and our spring and summer updates indicates it is able to connect some premises shown in our Connected Nations reports as being unable to receive decent broadband. Based on BT's modelling on the spring and summer updates, the number of premises without decent broadband may be as low as 80,000.[36]

The remaining premises may be able to have a new connection built under the broadband Universal Service Obligation (USO).[37]

We report on 4G indoor mobile coverage in the next section and, when we analyse the 123,000 premises against this data, we estimate that 38,000 premises cannot access either a decent fixed broadband service, or good 4G indoor coverage (of at least 2Mbit/s).

The Broadband Universal Service Obligation (USO)

The broadband USO provides everybody with the right to request a broadband connection with the following technical characteristics:

- a download sync speed of at least 10 Mbit/s;
- an upload sync speed of at least 1 Mbit/s;
- a contention ratio of no more than 50:1;
- latency which is capable of allowing the end user to make and receive voice calls effectively; and
- the capability to allow data usage of at least 100GB per month.

Where an affordable service with the above characteristics is not available, or due to become available in twelve months under a publicly funded scheme, the customer is eligible for the USO if the costs of providing the connection are below £3,400 or, where the costs are above £3,400, the

[35] We have gathered data from more networks; whilst these are small networks their footprint may sit in more remote areas where larger networks have not been deployed and so may help reduce the number of premises. In addition, we have worked with providers to improve reporting. In particular, BT has updated its reporting of its fixed wireless network coverage which has had a large impact on the reduction we have reported.

[36] We set out our approach to modelling coverage in our methodology. We use the latest available Ordnance Survey data to select the premises where a broadband service could be provided. Where operators use a different premises base than the one used by Ofcom, this can lead to gaps in reporting. While the impact is likely to be small overall, this can have an impact on decent broadband reporting given the relatively small number of premises.

[37] The Electronic Communications (Universal Service) (Broadband) Order 2018 [accessed 6 December 2021].

customer agrees to pay the excess. [38] In calculating whether the costs are below or above £3,400, the Universal Service Provider (USP) must take into account where costs could be shared by several USO eligible premises. BT is the USP for the UK (excluding Hull), and KCOM for the Hull Area. They are required to provide the USO and to report at six monthly intervals on delivery.[39]

BT's delivery of the broadband USO

So far, BT has received just under 1350 orders.[40] Each order may require network build that can serve multiple premises, and therefore these orders will lead to full fibre connections being built that can serve just under 6,500 premises that do not currently have access to decent broadband. These break down by Nation as shown in Figure 10.

Figure 10: USO orders and number of premises being built

	Number of USO orders	Total homes passed by resulting build
England	1100	5000
Northern Ireland	57	439
Scotland	84	288
Wales	108	689

Source: Ofcom analysis of BT data.

BT published its latest delivery report in October 2021.[41] These reports show that to date:

- it has received just over 20,000 requests to its USO Helpdesk;
- of these, around two-thirds were ineligible as a decent broadband product already existed from BT or another provider, or one would be made available within 12 months by a publicly funded scheme; and
- BT has connected just under 200 premises under the USO scheme. As stated above, network build may serve more than 1 premises. The build that has been completed may serve many more than these 200 premises. However, a connection is only provided once a customer places an order.

Shortly after the USO launched, we were concerned that BT may not be complying with the USO conditions correctly when it was calculating the excess costs for a given connection. This was potentially resulting in some customers receiving a quote for a connection that was higher than it should have been, leading to fewer people taking advantage of the USO. We opened an investigation

[38] In our statement of 6 June 2019 (para 5.1), we decided that an affordable service was one that cost £45 per month, rising annually by CPI. When the USO launched, this figure was £46.10.
[39] KCOM has received 1 request regarding the USO, which it found to be ineligible as a service meeting the decent broadband specification was available. KCOM does not consider any premises would be eligible for the USO because all customers can access either an affordable full fibre or a copper ADSL service. See Para 2.19, Ofcom, Statement: Compensating providers delivering universal services, 22 May 2020
[40] Data provided by BT to Ofcom includes orders up to 14 October 2021. BT's public reporting, up to 30 September 2021, indicates 1288 orders.
[41] BT, BT report on progress against the Broadband USO, [accessed 29 October 2021].

into BT's approach to calculating quotes for excess costs in October 2020.[42] In November 2021, we closed the investigation and amended the conditions imposed on BT so that: [43]

- BT would have to share costs appropriately amongst premises where the cost per premises was below £8,400 (£5,000 above the reasonable cost threshold), and would have to start build immediately after the first customer placed an order; and
- BT could wait until it had agreement to recover all the shared network costs of a build, where the cost per premises was higher than £8,400, to ensure that where excess costs are high BT will recover these costs given fewer customers might be prepared to pay these higher amounts.

Some premises may not get connected under the USO

Data analysis by BT indicates that in many cases, the costs to connect these remaining premises will be high so that many customers are likely to receive excess cost quotes above the £3,400 threshold. Those premises that are the most expensive to connect may need alternative solutions.

Satellite services may be an option for customers in poorly served areas

Satellite remains an option for a fixed broadband connection, particularly for premises without the alternative of a fixed provider. However, the number of customers accessing satellite services remains low in comparison with traditional broadband provision.

Geostationary (GSO) satellites orbit the earth at around 36,000km, and can be used to provide satellite broadband to premises across the UK, including the most remote premises, but the connection's performance can be limited by its latency, and by data caps that are commonly imposed on satellite broadband connections. But newer GSO services may offer improved services for consumers. For example, Konnect states that its satellite covers around 75% of the UK and offers commercial services on a 24/7 basis direct to consumers with download speeds between 30Mbit/s and 100Mbit/s, with upload speeds averaging 3Mbit/s.

We are beginning to see the introduction and deployment of Low Earth Orbit (LEO) satellite constellations that offer residential and business broadband to UK consumers. These services will have lower latency, because the satellites are closer to Earth, so they are more likely to provide better broadband services. However, the throughput that a customer receives will also depend on the number and capacity of satellites and available spectrum, which will be shared between users of the service.

SpaceX's Starlink service has been launched and is currently in beta trial. It offers direct to consumer services on a 24/7 basis in most of the UK with future coverage for the whole of the UK planned. Starlink indicates that users can currently expect to see 100 to 200 Mbit/s or greater download speeds and upload speeds of 10 to 20 Mbit/s with latency of 20ms or lower in most locations.

[42] Ofcom, Investigation into BT's compliance with its obligations as a broadband universal service provider, October 2020.
[43] Ofcom, Statement: Approach to high excess costs under the broadband universal service, 11 November 2021.

Other LEO services include OneWeb, which aims to provide 24/7 coverage of the entire UK by the end of 2021, with services available via distribution partners in 2022. We understand it will have a focus on backhaul and services for businesses initially.

We plan to conduct broadband performance measurements on satellite connections to understand in more detail the performance that can be delivered on these networks.

Private and public sector investment play a role in building faster networks

Supporting investment in faster networks across the UK is a key priority for Ofcom. While commercial and public sector investment has delivered at least superfast services to most of the UK, not every part of the UK has the same access to faster speed services. Therefore, we are continuing our work to both improve access to better broadband services in the hardest to reach locations, and support investment in new gigabit capable networks.

Investment in telecoms network infrastructure increased by 9% to £6.3bn in 2020

Over half of network investment in 2020 was in fixed network infrastructure, including full fibre

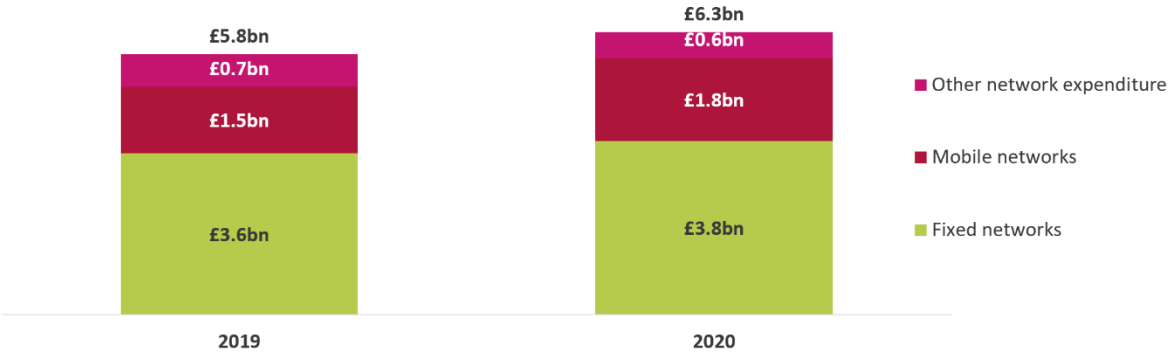
We collected network capital expenditure (CAPEX) data from over 30 of the UK's largest fixed and mobile telecoms providers to help us understand how telecoms providers are investing in network infrastructure.[44]

The information is collected from telecoms providers and relates to their annual financial reporting periods. As financial reporting periods can differ from provider-to-provider, we have pro-rated the data to estimate network investment in the calendar years 2019 and 2020.

The figures shown below include any public funding provided to support the rollout of better fixed and mobile connectivity, such as UK Government funding, funding provided via the governments of the devolved nations and local authority funding.

[44] Only capital expenditure required to provide and operate network infrastructure in the UK is included: figures exclude VAT and expenditure on retail activities (e.g. retail billing or marketing systems). Figures include capital expenditure on tangible and intangible assets, including capitalised staffing and labour expenditure, and expenditure on assets in the course of construction (AICC). Figures exclude expenditure on assets that have been added to a balance sheet through adoption of the IFRS16 accounting standard, on assets held for sale and the costs of maintenance contracts purchased alongside hardware. Expenditure associated with asset transfers and leasing follows the same guidelines the Office for National Statistics provides when requesting information in its quarterly acquisitions and disposals of capital asset survey. While the figures shown have been rounded, any percentage changes shown are calculated using the unrounded data.

Figure 11: Telecoms network capital expenditure: 2019 and 2020



Source: Ofcom / operator data.
Note: Adjusted for CPI (2020 prices).

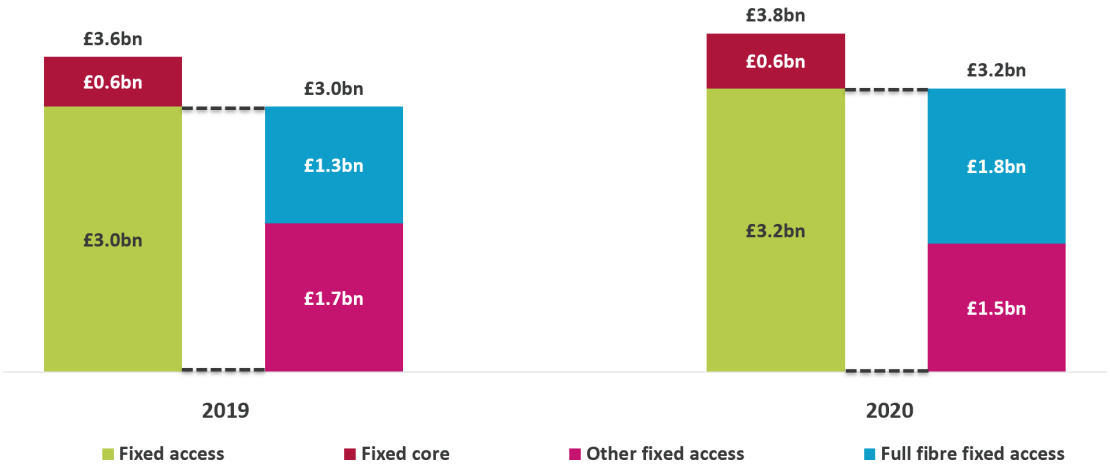
Expenditure on fixed telecoms network infrastructure increased to £3.8bn in 2020

Data collected from more than 25 of the UK's largest fixed telecoms providers suggest that UK telecoms providers invested £3.8bn in fixed network infrastructure in 2020, a £0.3bn (7%) increase in real terms compared to 2019. In addition to this, £0.6bn was invested in infrastructure that is used to provide both fixed and mobile telecoms services in 2020.

Investment in access network infrastructure accounted for most fixed network investment during the year, (£3.2bn, or 84% of the total), with fixed core and backhaul networks accounting for the remaining £0.6bn (16% of the total). These proportions were unchanged from 2019.

Gigabit-capable full fibre access network investment totalled £1.8bn in 2020, a year-on-year increase of £0.4bn (32%). In addition, a proportion of the £1.5bn that was spent on other fixed access services may also support deployment of gigabit-capable networks where this relates to upgrades to physical infrastructure (such as fibre deployments for fibre-to-the-cabinet) that could be re-used in future.

Figure 12: Fixed telecoms network capital expenditure: 2019 and 2020



Source: Ofcom / operator data.
Notes: Adjusted for CPI (2020 prices); the split of full fibre access and other fixed access investment for 2019 data has been updated to reflect operator restatements.

Public sector investment has a key role in delivering connectivity

Governments across the UK continue to supplement commercial rollout by investing in faster speeds for the hardest to reach areas. While subsidy schemes designed to bring superfast speeds continue to operate, governments are also now using public funding to support gigabit-capable connectivity.

The UK Government has set a target of at least 85% gigabit coverage by 2025, alongside an ambition to get as close to 100% as possible. To help achieve this, the Government has committed £5 billion in investment as the UK Gigabit Programme, with at least £1.2bn available by 2025, to provide connectivity for the hardest to reach areas. The first procurement rounds have now commenced, with the first contracts likely to be awarded in 2022 with build commencing thereafter.

Examples of ongoing government schemes to support faster speeds in hard to reach areas include:

- Alongside the UK Gigabit Programme, the UK Government provides vouchers including through the Gigabit Broadband Voucher Scheme for individual eligible customers to contribute towards the installation of faster connections using gigabit-capable infrastructure.
- The Welsh Government awarded its Superfast Cymru successor scheme contract to Openreach, which is expected to provide full fibre to 39,000 premises, in three lots across Wales by June 2022. This will be achieved with £56m of public subsidy from the Welsh Government and EU funding. This contract is already known to have completed 31,531 premises. It is focused on tackling premises in the final 4% of Wales that can't yet access speeds of 30Mbit/s.
- In Scotland, the Scottish Government has committed to ensuring every home and business in Scotland can access superfast broadband. This commitment will be delivered through the Reaching 100% (R100) programme via three key strands of activity – the £600 million R100 contracts (North, Central and South), the Scottish Broadband Voucher Scheme (R100 SBVS) and ongoing commercial deployment. Contracts for R100 in all three lots have been signed with BT and will go beyond the original commitment to provide superfast broadband by providing a significant number of gigabit-capable and full fibre connections.[45] Work is now underway in all three lots and the Scottish Government is working with Openreach to identify opportunities to accelerate this where and when possible.
- In Northern Ireland, Project Stratum is utilising £165m of public funding to target premises that can't get a service capable of delivering a download speed of 30 Mbit/s (Superfast). 76,000 premises were included in the project, and in August 2021, the Department for Digital, Culture Media and Sport allocated an additional £25m towards bringing an additional 8,500 premises into the project. The first premises were connected in Coalisland, Co Tyrone in March 2021, with over 19,000 premises expected to be passed by the end of 2021.

More information about schemes run by the devolved governments is available in the individual nations reports.

Working with the UK and devolved governments, Ofcom will continue to focus on ways to deliver decent connectivity to all. In particular, the UK government consulted earlier this year on the

[45] Scottish Government, Improving broadband access, 2 September 2021.

premises in the hardest to reach locations where even the broadband USO and other public schemes will not reach,[46] and we will work with the government as it develops its policy in this area.

More consumers are upgrading to higher speed packages

More people are taking up full fibre

Having discussed coverage, and the investment in improving the availability of networks, we now report on take-up. The benefits of increased coverage of broadband networks able to support higher speed services cannot be realised if consumers do not take advantage of these services when they are available.

We estimate that the take-up of services using full fibre at any speed, where fibre is available, is around 24%.[47] Our reporting of full-fibre take-up may appear lower than expected because, whilst networks are being deployed at pace, take-up is likely to lag behind coverage. This occurs because the new fibre services may not be advertised until the network is available so that there is a lag in awareness of availability, and consumers may need to wait until their existing service contract ends before they can migrate to a new fibre service. But, in absolute terms, take-up is increasing rapidly with the number of full fibre connections increasing by at least 750,000 in the year to September 2021.[48] Figure 13 below provides a breakdown of full fibre take-up as a percentage of premises where full fibre services are available.

Figure 13: Estimated full fibre take-up as a percentage of premises where full fibre services are available: 2020 and 2021

	2021	2020
UK	24%	25%
England	25%	27%
Northern Ireland	19%	11%
Scotland	22%	25%
Wales	24%	22%

Source: Ofcom analysis of provider data.

Customers taking a full fibre broadband service can usually choose from a range of speeds. Approximately half take a package that delivers a download speed of up to 100Mbit/s. Take-up of gigabit speed services is still low, with around 7% of full fibre customers taking these higher speed services.

[46] GOV.UK, Improving broadband for Very Hard to Reach premises [accessed 3 December 2021].
[47] This take-up figure refers to the underlying technology; customers can often choose a range of speed tiers over full fibre technology.
[48] Our estimate of 750,000 is based on take-up data from a subset of providers offering full fibre. These are the largest providers and so will account for the majority of customers. We have not estimated take-up of smaller providers that have not submitted take-up data to us.

Take-up of superfast broadband has increased to over two-thirds

Overall, we estimate that for those premises that are able to take superfast broadband or a higher speed (96% of all premises in the UK), around 69% of them do so. This is an increase from around 60% last year. Take-up of superfast broadband or faster is highest in Northern Ireland; take-up has increased in all nations in the last year.

Figure 14: Estimated superfast take-up as a percentage of premises where superfast services are available: 2020 and 2021

	2021	2020
UK	69%	60%
England	69%	61%
Northern Ireland	73%	65%
Scotland	68%	57%
Wales	66%	55%

Source: Ofcom analysis of provider data.

Getting connected to full fibre networks depends on timely installation

Customers can only take advantage of the increasing coverage of new full fibre networks where connections can be provided in a timely fashion.

The coverage information we publish, both in this report and our associated maps and open data, shows where connections at the speeds indicated are available. For broadband services using the telephone line, such as standard broadband, the connection usually already exists to the property. However, in the case of full fibre connections, the network provider may have installed network close to the property but still needs to install the final connection to a property in order to provide service.

We asked full fibre providers the length of time it would take to make this connection. We found that there was a broad range of installation times. For those providers that provide fibre networks to new-build and campus developments, connections are built into the fabric of the properties, and hence connection times are effectively instantaneous. In general, we found that almost all operators are able to provide connections within 28 days of a customer order. In some situations, longer connection times may arise, either because of the geography (such as accessing very rural communities) or due to gaining necessary permissions to access private land.

This year we also asked a subset of full fibre providers about how often they complete a new physical connection within their respective standard connection provision time in order to gauge whether the providers were meeting their expected targets. More often than not, the full fibre providers were able to meet their targets. Where the full fibre providers were unable to meet their targets, the most common reason stated by the providers was when the customers requested them to arrange the appointment for a later date. However, other issues mentioned to us included complex construction challenges, engineering resource constraints and delays incurred between access network build completion and the operational ability to offer retail services to customers.

Networks need to make sure they have capacity to connect new customers

In some circumstances it is not possible to provide a broadband service to a new customer even though there is network coverage. This can arise because the network in the area is reaching the limits of its capacity, and therefore requests for service at the desired speed cannot be met. It may also arise if additional connections exceed the physical number of ports on equipment in the access network (such as a street cabinet or exchange equipment).

Similar to our 2020 report, we have again estimated that across the UK, fixed access networks had the capacity to meet additional demand from users 99% of the time. The underlying reasons for capacity constraints remain consistent, with more network providers reporting some, albeit low levels of capacity limitations.

To investigate the 1% of cases where demand could not be met, this year we also asked providers about the length of time they were unable to accept additional customers due to such capacity constraints and the reasons for this. This varied considerably, from a few days to many months, depending on the specific solution used to implement additional capacity. Other factors such as permission to carry out the work and resource constraints played a role as well, with one provider highlighting the impact of Covid-19 on their ability to carry out upgrades. Openreach mentioned that port limitations within its FTTC street cabinets are often mitigated by customers being able to upgrade to FTTP or G.fast, rather than by adding new capacity. Based on the responses we estimate that most capacity constraints are resolved within two months. However, in a very small number of cases, they have remained in place for much longer.

Helping customers choose the right broadband service

Consumers will be best placed to decide which service most suits their needs if they understand the range of options available to them. Ofcom has work underway to help consumers understand their broadband choices, and to see the potential benefits that faster connections may give them. Ofcom seeks to help consumers understand the broadband choices available to them, and to understand the additional benefits of a faster connection.[49] Our coverage checker also shows the network providers that are available at a particular location.[50]

We have also worked to help consumers know when their contract period is coming to an end, and what their options are when it does. Since February 2020, providers have been required to issue End of Contract Notifications (ECNs), which tell people when their contract is coming to an end, what they will pay when it does, the best deals their provider can offer them (as well as any prices only available to new customers), and that they have the choice to switch providers at the end of their minimum contract period if they wish.[51] Additionally, providers are required to issue Annual Best

[49] How to get more from your broadband
[50] View broadband availability
[51] Ofcom, Companies must tell customers about their best deals, 14 February 2020. Providers were required to send ECNs from February 2020, and ABTNs within 12 months from then for contracts that were already in force at that date – in effect this means that most providers began sending ABTNs from February 2021.

Tariff Notifications (ABTNs) to their out of contract customers, telling them that they are out of contract and the best tariffs they can offer.[52]

Consumers can find it difficult to choose their broadband service among the different offerings and we believe that it is important they have the right information to make informed decisions about their broadband. In June 2021, the taskforce convened by the UK Government to drive consumer take-up of gigabit speed internet connections ('GigaTAG') published its final report. [53] The report included the recommendation that Ofcom and industry should develop common terminology to describe broadband services and a core set of use cases and benefits to be used by providers. We have already started to engage with providers and consumer groups to develop a set of common standards for consumer information on broadband services.

The UK's traditional telephone network is also being replaced

It is not only the UK's fixed broadband networks that are changing – traditional landline services are also undergoing a substantial transition. Network providers such as BT, Virgin Media O2 and KCOM, that offer traditional telephony services, are in the process of retiring their legacy systems (referred to as the Public Switched Telephone Network, or 'PSTN') and replacing them with modern systems.[54] In particular, BT and Openreach plan to retire BT's PSTN network and the Openreach wholesale services that deliver that capability by the end of 2025. To make sure that landline services continue in future, providers which currently use the legacy telephony networks will deliver landline calls over a digital technology called Voice over Broadband (VoBB), which uses Voice over Internet Protocol (VoIP) over a broadband connection.

Analysis of provider data shows that around 15% of landline services are now delivered over broadband, up from 8% last year. Increasingly, customers have their landline service moved to VoBB when they change provider or upgrade their phone and broadband package. In addition, BT and Virgin Media O2 have started to migrate existing customers. We are monitoring the migration and continue to engage with providers to help ensure consumers are protected and disruption is minimised.

At the same time, broadband customers can choose a 'broadband-only' package, where they are no longer required to take a phone service. Broadband-only packages – with or without the option to add a landline service – are offered by most full fibre providers, and are increasingly being offered for copper-based broadband as well. With landline usage falling, we anticipate that adoption of these packages will grow significantly in the coming years, with a corresponding decrease in the number of landlines. [55] We also note consumers are using mobile phones to replace or complement fixed connections.

The migration from the legacy telephone network also brings certain challenges. We discuss these challenges in more detail in the Security and Resilience chapter.

[52] Ofcom, Helping customers get better deals: a review of the impact of end-of-contract notifications and pricing commitments by broadband and mobile providers, 30 November 2021.
[53] GigaTAG, Gigabit Take-up Advisory Group: Final Report, [accessed 7 December 2021].
[54] In the case of BT, PSTN services are provided by Openreach in terms of access connectivity and BT for calls services. Openreach's WLR withdrawal site gives more information.
[55] Ofcom's Communications Market Report 2021.

Data usage over fixed connections continues to grow

Access to higher speed networks offers the opportunity for consumers to access faster, more bandwidth heavy services.

Consumers continue to use more data over their fixed connections as more people use broadband for data-heavy activities such as streaming. Average monthly data usage now stands at 453 GB per connection, up from 429 GB last year and 315 GB in 2019.[56]

During 2021, nationwide lockdowns, and subsequent restrictions, due to the Covid-19 pandemic have continued, meaning many people have been using their home broadband connections for work and school, for keeping in touch with friends and family, for accessing essential services, and for leisure.

Overall, the growth in average monthly download traffic has slowed this year to around 5%, but peak download traffic (in the period 6pm to midnight) has grown more, by around 13%. The figures for this year were recorded during May as the UK eased lockdowns, with different Nations taking different approaches.[57] This compares to last year, when the data was gathered in June at a time when the initial very strict lockdown had eased but strict restrictions were still in place and many people were still working from home due to the Covid-19 pandemic.

To understand how traffic has changed over the last year, we again requested data spanning the period from February to July. This captures the period from full lockdown to when these restrictions were being lifted. This was the same period as we looked at last year.

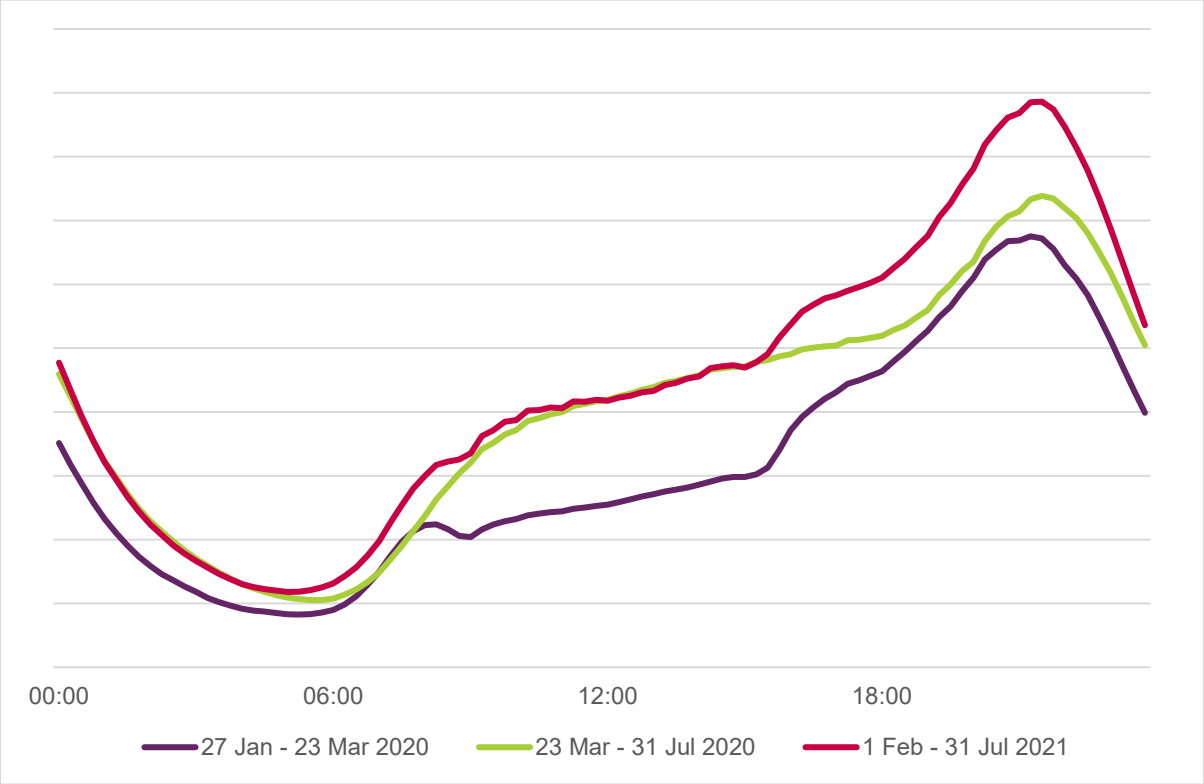
Some communications providers were able to provide detailed reports covering the entire period, whereas others had higher level analysis, or data for only part of the requested period. Figures 15 and 16 show the typical traffic profile for weekdays and weekends for three periods:

- Prior to national lockdown in 2020;
- The period of lockdown from late March to July 2020; and
- The period of lockdown from Feb to July 2021.

[56] These figures include connections not assigned to a specific location within the UK; equivalent figures in Nations reports include only connections assigned to addresses in that Nation. The UK average given here therefore includes data for premises not included in the figures given for each individual nation in the Nations reports.

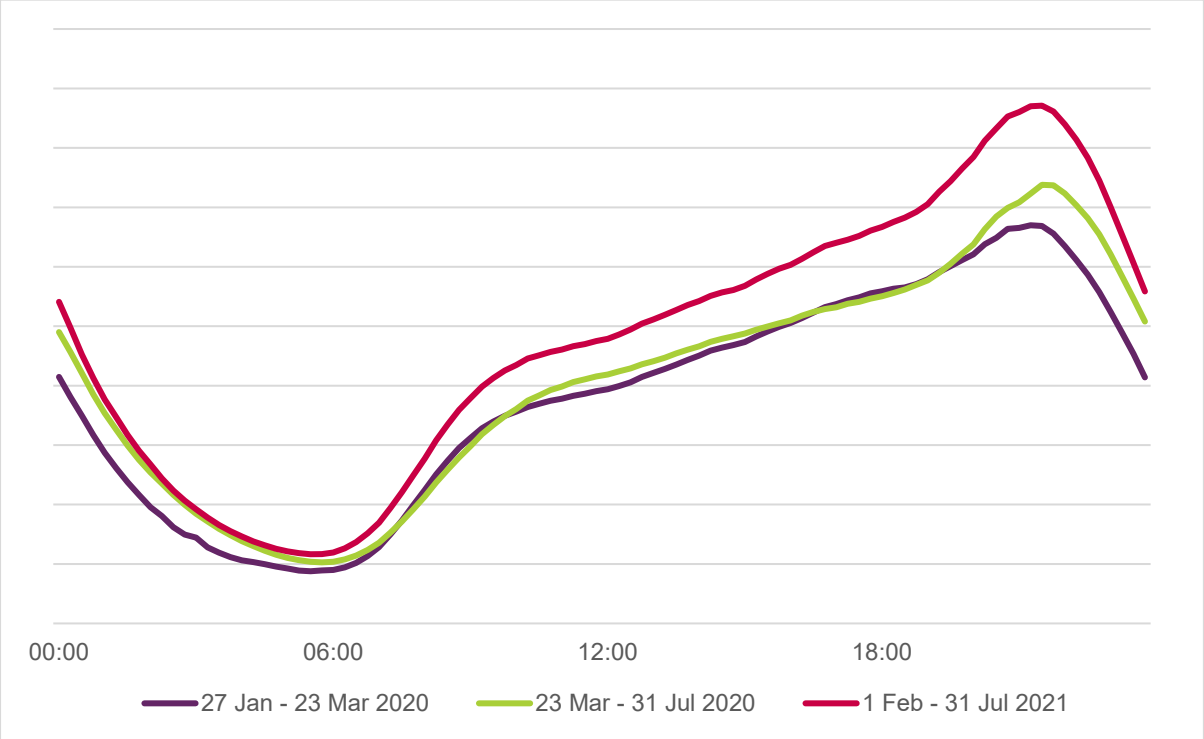
[57] At this time, many people were still working from home on a permanent or regular basis. Entertainment venues such as pubs were open to different degrees and with different rules in different Nations.

Figure 15: Average traffic profile (Gbit/s) on weekdays before national lockdown (27 Jan to 22 March), during national lockdown and subsequent restrictions in 2020 (23 Mar to end July), and during national lockdown and subsequent restrictions in 2021 (1 Feb to end July)



Source: Ofcom analysis of provider data.

Figure 16: Average traffic profile (Gbit/s) on weekends before national lockdown (27 Jan to 22 March), during national lockdown and subsequent restrictions in 2020 (23 Mar to end July), and during national lockdown and subsequent restrictions in 2021 (1 Feb to end July)



Source: Ofcom analysis of provider data.

The charts show that:

- peak traffic remained in the evening; and
- the significant increase in traffic during the weekday once nationwide lockdowns were introduced continued.

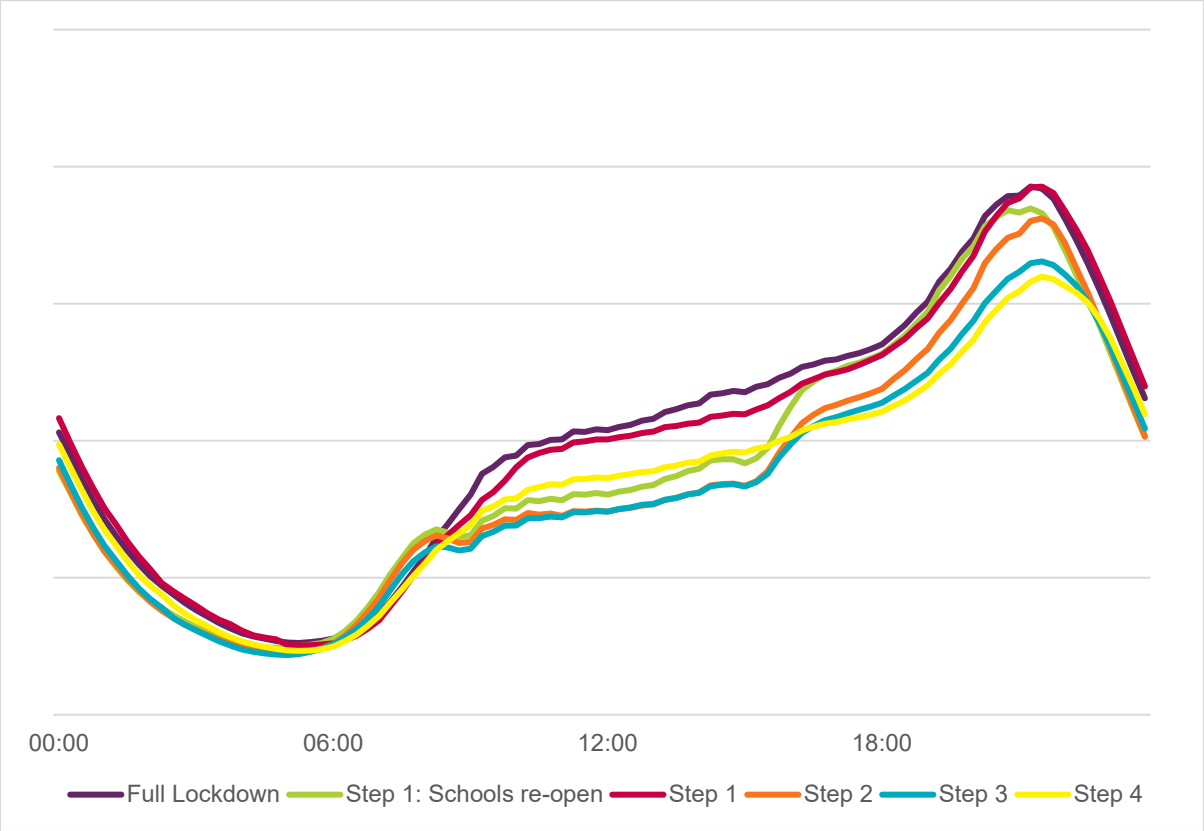
Whilst the above chart overall shows a higher peak in 2021 than 2020, several providers reported that increases in the peak were lower at the end of the period year on year (i.e. year on year growth from June/July 2020 to June/July 2021 was lower than in earlier months). However, we note that peak traffic does continue to grow and is likely to be driven by video streaming and gaming. Video streaming of live events can also lead to unexpected and/or volatile traffic peaks (for example, streaming of sports events can drive significant demand).[58]

The weekday data for 2021 shows an increase in traffic around 4pm. This is consistent with the peak seen pre-Covid restrictions and represents an increase in traffic as children finish school. Figure 17 below shows, for 2021, the weekday profiles for different stages of lockdown in England.[59]

[58] See for example: Openreach on Twitter: "Crouch. Bind. Stream. Last week was the busiest week of network traffic for the last six months. The spike was due to fans streaming the Rugby Autumn Internationals online over the weekend. Autumn is in full swing #WeAreOpenreach #AutumnInternationals"

[59] We note that lockdown steps were different in different Nations. The data shown is for the UK and will be driven by usage in England as the largest Nation.

Figure 17: Average traffic profile (Gbit/s) on weekdays by step of lockdown easing in England



Source: Ofcom analysis of provider data.

Where: Full lockdown is the period from 1 Feb to 7 Mar; Step 1: Schools re-open is the period from 8 Mar to 28 Mar; Step 1 is the period from 29 Mar to 11 April; Step 2 is the period from 12 April to 16 May; Step 3 is the period from 17 May to 18 July; and Step 4 is the period from 19 July to 31 July.

From Figure 17 we note that:[60]

- Weekday traffic was highest during full lockdown up until 7 March. This was particularly true during the day, but also in the evening.
- When schools returned, daytime traffic fell until around 4pm when traffic increased as children finished the school day.
- Higher daytime traffic was seen as schools were on holiday during the two week period from 29 March when Step 1 measures other than schools opening were implemented.[61]
- Each step easing lockdown saw an overall reduction in traffic.

As last year, networks have coped with the additional demand as a result of the lockdown. Providers plan their networks to have spare capacity to cope with year on year traffic growth and spikes associated with especially busy events. This has provided sufficient headroom to cope with any increased peak demand during the pandemic.

[60] Some of these steps cover different periods (for example Step 1 covers only 2 weeks. As such caution should be taken in placing too much weight on these specific charts, which are presented for illustrative purposes.
[61] Daytime traffic during Step 4 from 19 July is higher. This is consistent with usage during school holidays starting late July and with some children having finished school after exams.

Sustainability

As the UK progresses towards its net zero target,[62] it is vital that we all consider how we live and work from an environmental sustainability perspective. Meeting this target will include reductions in businesses' own greenhouse gas (GHG) emissions, greater use of renewable energy and consideration of embodied carbon. Businesses have a crucial role to play, and it is encouraging to see many fixed and mobile services providers commit to reducing their own environmental impacts.

The telecommunications services sector's CO2 equivalent emissions, on a consumption basis was estimated to be 0.08% of the UK's total in 2018, at 471,000 tonnes. The sector's CO2 equivalent emissions on a production basis was estimated to be 0.06% in 2019, equating to 308,800 tonnes.[63]

Providers have responded in a range of ways such as signing up to net zero pledges, integrating environmental sustainability principles into business decisions, championing schemes to reduce waste, and working with supply chains to reduce wider impacts. For example, during the 2021 financial year, some MNOs invested in energy efficiency and on-site renewable projects for their base station sites and technology centres, as well as energy efficiency management programmes, resulting in savings in energy consumption and running costs. Beyond reducing their own emissions, communications providers have a crucial role to play in enabling the UK to become more efficient and productive, empowering people and businesses to tackle their environmental impact. Communications can help society reach net zero by reducing GHG emissions, through networks, goods and services, such as smart buildings, smart logistics, smart grids or reducing travel by shifting to virtual meetings.[64]

As the regulator, we want to see investment in the latest technologies. But if these investments are to benefit consumers in the long term, they need to be sustainable financially and in terms of their wider impact on society. We will continue engaging with our industry stakeholders to understand their approach to running their businesses sustainably. All firms in the sector will need to understand how they affect the environment, how technologies can enable emission reductions in other sectors, and what actions could help achieve the UK's future net-zero carbon target.

[62] The International Panel on Climate Change (IPCC) defines net zero as that point when "anthropogenic emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals over a specified period." https://www.ipcc.ch/sr15/chapter/glossary/ [accessed 7 December 2021]

[63] Consumption figures (2018) are from: UK's carbon footprint (www.gov.uk). The consumption carbon footprint refers to emissions from the worldwide production of goods consumed in the UK as well as goods produced in the UK and emissions directly generated by UK households. Production figures (2019) are from the Office of National Statistics [accessed 9 December 2021]. The production emissions are compiled on a residency basis, covering emissions from UK residents and UK-registered businesses regardless of whether they are in the UK or overseas. Greenhouse gases under the Kyoto Protocol: carbon dioxide, methane, nitrous oxide, hydro-fluorocarbons, perfluorocarbons, nitrogen trifluoride, sulphur hexaflouride.

[64] https://www.itu.int/rec/T-REC-L.1471-202109-I [accessed 7 December 2021]



Mobile, data and voice

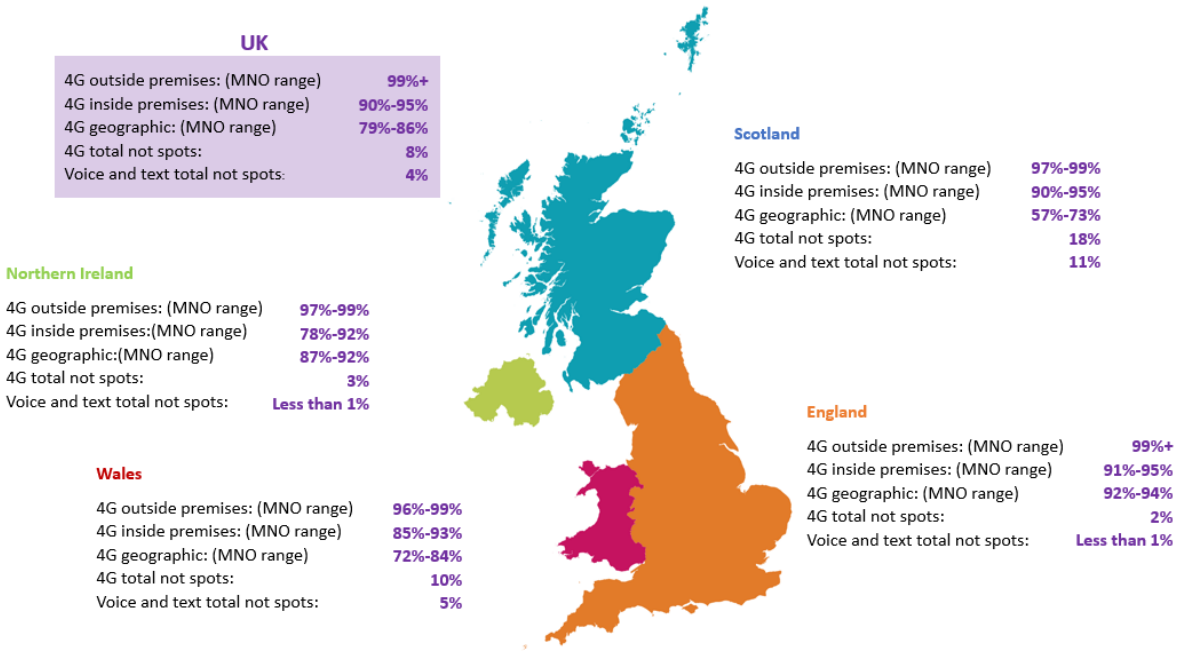
Introduction

Mobile services play an ever-increasing role in people's lives. In this chapter, we report on the availability of mobile coverage, outside and inside premises, across the UK's landmass and on roads. We provide an update on developments in the rollout of 5G over the last year, and provide a first view of how extensively 5G is available. We also address investment in, and the take up of mobile services, as reflected in the continuing growth of mobile traffic. Finally, we also report on the availability and use of 'Internet of Things' devices and services.

Key highlights:

- 5G is available from at least one MNO in the vicinity of c42-57% of UK premises (with a higher reliability of receiving a service at the lower end of this range). 5G remains largely focussed on adding capacity in urban areas, and this coverage represents only a small part of the UK landmass.
- 4G continues to underpin mobile experience in the UK, especially coverage for data services. 2021 has seen BT EE's geographic coverage rise 1 percentage point to c86%, alongside smaller increases from other Mobile Network Operators (MNOs), as the early impact of the Shared Rural Network and ongoing rollout to support the Emergency Service Network take effect.
- As consumer uptake of 5G enabled handsets increases (now c10% of devices) more traffic is being carried over 5G, rising from 1% of total traffic in 2020 to 3% this year. 4G traffic continues to grow, and remains the dominant technology for mobile traffic.
- Operators continue to manage dynamic behavioural changes resulting from Covid 19, as some but not all traffic returns to urban cores. Operators have met this challenge by deploying additional capacity in new places, particularly hotspot holiday locations.
- Internet of Things (IoT) connections grew substantially over the last year, with connections on MNO networks alone rising to more than 10 million. Although the overall volume of IoT data traffic remains less than 1% of all traffic, total IoT traffic has more than doubled year on year.

Figure 18: Summary of mobile coverage across the UK Nations



Source: Ofcom analysis of operator data, September 2021.

5G rollout and adoption is evolving

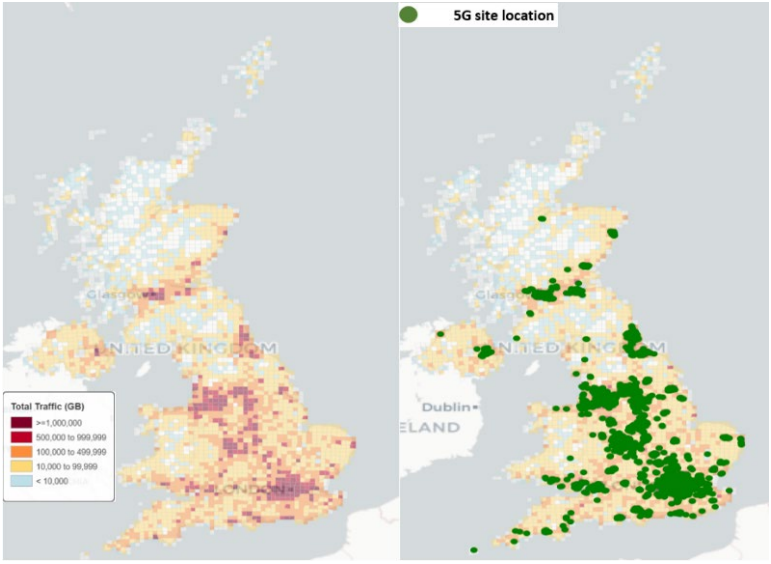
5G deployment has continued at pace in 2021, and now stands at more than c6,500 5G mobile sites across the UK, up from c3,000 in 2020. 87% of these sites are in England, 8% in Scotland, 3% in Wales and 2% in Northern Ireland.

Consumer take up remains relatively modest, but has increased substantially, with around 800,000 active 5G devices across all mobile operator networks in the UK in 2020 rising to more than 6 million handsets in September 2021. For MNOs this represents c10% of all active devices.

5G in the UK has been commercially rolled out initially in Non-Stand-Alone (NSA) mode, relying on a 4G core network, and using 4G for signalling and network control functions. This means that user services can be delivered over 5G, or a combination of 4G and 5G, which can place constraints on some of the full capabilities of 5G.

5G continues to be deployed to provide additional capacity in already busy areas, and is present on roughly half of the UK's 3,000 busiest sites (in terms of total traffic carried). Dense urban deployments of the high capacity 3 GHz spectrum (auctioned in 2018 and early 2021) predominate, however these are beginning to be supplemented with deployments in hotspot suburban areas and around transport corridors. Around 20% of sites in urban areas now have 5G deployed on them, compared with around 5% in suburban areas.

Figure 19: UK monthly mobile traffic (left) in relation to 5G site deployments (right)



Some of the locations highlighted above include areas where UK operators are deploying dynamic spectrum sharing (DSS) to roll out lower frequency 5G to suburban areas.[65] Where DSS is in commercial use by MNOs it represents on average c16% of 5G enabled sites in their portfolios, and offers a potential route to rapid further deployment of 5G. However, since it utilises existing spectrum it does not offer the same capacity gains as dedicated 3 GHz deployments. Available capacity across 5G deployments can further vary and be boosted to different degrees by the use of different MIMO antenna configurations, with a range of approaches being used by MNOs. [66]

What 5G means (alongside 4G, 3G and 2G) for consumers and businesses

Throughout this chapter, we report on the coverage available through more established 2G, 3G and 4G technologies, as well as the traffic carried upon them, alongside 5G. These technologies continue to underpin the service upon which the majority of consumers (at least 90%) rely. Indeed, notwithstanding the uptick in 5G handset availability and significant growth in deployment, 5G carries only 3% of the total UK mobile traffic, indicating that this remains a relatively small part of the mobile experience for most consumers.

Where a mobile site is not heavily loaded both 4G and 5G technologies can support most of the demanding use cases typically required by today's consumers. 5G has some unique features – for example, the potential to significantly reduce latency, which could enable the development and growth of certain newer applications (e.g. augmented reality or virtual presence) in the future. However, while our Mobile Matters report found that the latency of 5G connections was approximately 20% better than for 4G, this is unlikely to be noticed by today's smartphone user. [67]

[65] Dynamic spectrum sharing enables the parallel use of 4G and 5G in the same frequency band, as the technology determines the demand for 5G and 4G in real-time.
[66] MIMO, meaning multiple input multiple output antennas. We have seen MNOs adopt a range of approaches in 5G deployments, with around 44% of antennas found to be at either 32Tx32R or 64Tx64R (supporting the greatest capacity and throughput enhancements); around 45% at 8Tx8R; and the remainder at lower configurations (e.g. 2TX2R).
[67] Mobile Matters 2021, page 16 [accessed 7 December 2021].

The introduction of Stand Alone 5G may enable further improvements, where this is combined with more localised investment in data storage to achieve transformative experiences.

Figure 20: illustrative summary of use cases by mobile technology

Technology	Typical use cases (subject to demands on capacity)
5G Stand Alone (mid frequency & above)	Fastest connection speed, highest capacity, potential for ultra-low latency applications (and including 4G use cases)
5G NSA (mid frequency)	More capacity to support more people undertaking high data rate services e.g. higher volumes of demanding 4K video users (and including 4G use cases)
5G NSA (low to mid frequency)	General web browsing, social media, gaming, video streaming (and including 4G use cases)
4G	General web browsing, social media, gaming, video streaming (and including 3G use cases)
3G	Basic web browsing (and including 2G use cases)
2G	Voice calls, text, very low data rate applications

Although newer applications may become associated with Stand Alone 5G and the deployment of larger bandwidths (mid frequency and above), many such services are also likely to be possible on lower frequencies when there are fewer users in an area (for example in rural areas). Given the potential for different technologies to provide similar performance levels in the right circumstances, and the range of experiences that are possible (even on the same technology), we intend to develop new approaches to report in more detail on the quality of performance possible in different areas in the coming year.

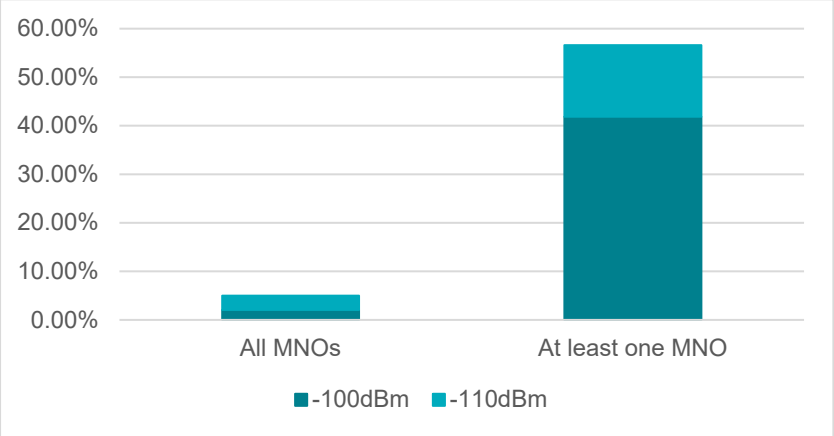
5G is available in many populated areas, although comprehensive coverage across MNOs is less extensive

5G rollout is evolving rapidly. We recognise that operators are still refining their 5G rollout plans, optimising their 5G networks and are still developing approaches to reporting on 5G (both to Ofcom, and directly to their customers). We therefore expect that further work in the coming months may yield refinements to these approaches and the data we collect. Nevertheless, more than two and a half years on from the commercial launch of 5G and with growing consumer take up, there is a significant interest in understanding how extensively 5G is available. Ofcom has worked with mobile operators to understand best practice for 5G reporting and seek a common reporting framework. This remains work in progress.

In light of this evolving picture and ongoing work, we are providing a view of where 5G is predicted to be available[68] from 'All MNOs', and from 'At least one MNO'[69], based on the information provided to us by operators, and informed by our own measurement work.[70]

Given the current level of 5G deployment, it is challenging to conclude on a single margin to define the reliability of a 5G service being available at this stage. Below we provide a view of 5G coverage availability outside premises across a range that provides increasing confidence of a reliable connection, from high confidence (-110 dBm) to very high confidence (-100 dBm).[71]

Figure 21: 5G coverage outside premises – by all and at least one MNO



Source: Ofcom analysis of operator data

The area where 5G coverage is available from all MNOs is significantly lower because this metric is constrained by the footprint of operators with the least coverage and localised differences in coverage coming from different site locations. It represents areas with maximum choice between MNOs, but provides a view of coverage that is lower than any 5G consumers would experience. Geographic 5G availability remains modest, with coverage from at least one MNO ranging between 6-10% of the landmass across these thresholds, reflecting the continued emphasis on 5G deployment in busier urban areas.

We are providing this perspective to give an indication of current 5G rollout. We are not able to report on individual mobile operator coverage for two main reasons:

- Although MNOs have undertaken some validation of their 5G predictions, this work remains ongoing. In addition, our own measurement work leads us to consider that while the above

[68] By Availability we mean where a consumer handset can reliably access a 5G network. We expect that where a handset can do this, a consumer will at least be able to access core services and in many cases significantly greater performance levels will be possible. We expect to report on quality of performance (for 4G and 5G) in the future.

[69] By 'At least one' we mean the total area in which 5G is potentially available from an MNO, although this service may be from one operator in one location, and another elsewhere.

[70] Our current measurement methodology for 5G (and 4G) is available on our website.

[71] In this approach, we have associated the signal strength which an operator predicts to provide (in dBm) with a confidence level for coverage being present on the ground. The higher signal level (-100 dBm) implies higher confidence. We set out our approach in more detail in Annex A
https://www.ofcom.org.uk/__data/assets/pdf_file/0023/229505/connected-nations-2021-methodology.pdf

ranges are appropriate, we are not in a position to be certain of this for individual MNO predictions; and

- The mobile operators currently have different views on what thresholds are appropriate for a high confidence of 5G availability. This may reflect both the ongoing nature of validation work on 5G, and evolving choices in network and traffic management strategies.

Ofcom will continue to work with MNOs to establish a more common approach to reporting, which should focus on providing consumers with information on coverage that is reliably available where it is predicted. This work will require MNO validation activity to be completed as soon as possible to ensure the accuracy of the information provided both to Ofcom and to consumers in MNO coverage maps. In addition, we will work towards an industry consensus on appropriate reliability margins for reporting coverage to avoid consumers receiving inconsistent coverage information from each MNO.

5G is also enabling MNOs and others to explore new private network opportunities

Last year, we highlighted the emerging opportunities for private networks enabled by 5G, as a result of its ability to afford organisations greater control over operational processes, with near instantaneous communications and the ability to guarantee quality of service. This remains an active and developing area, with the opportunity for a broader set of players to emerge as localised communications providers.

Over the course of 2021, there have been a number of announcements from organisations investing in private 5G networks:

- O2 launched a 5G private network development with Leonardo (a Ministry of Defence supplier) for a range of industry applications (e.g. next generation manufacturing);[72]
- Verizon and Nokia are developing a private 5G network for Associated British Ports in the Port of Southampton, enabling a more reliable and secure private wireless data network across areas in the Port;[73]
- Telent (whose clients include Transport for London, Highways England, BT/Openreach) launched its first 5G private network service and test facility.[74]

A number of schemes in operation are benefitting from the UK Government's Test beds and trials programme,[75] which in early 2021 announced £28 million to fund various use cases for 5G, including real time goods tracking at the ports of Felixstowe and Bristol, and testing 5G-powered cameras, drones and sensors for the construction industry in Scotland.[76]

Whilst MNOs are involved in this work, live commercial offerings of MNO private networks remain limited. As of September 2021, the number of fully operational commercial private networks run by

[72] WM5G, O2 UK partners with aerospace company to test private 5G networks, O2, 5G Private Networks and their role in transforming Defence and Manufacturing Industries.
[73] Verizon, Verizon signs its first European private 5G deal with Associated British Ports.
[74] 5Gradar, Telent launches new service to develop private 5G networks.
[75] The 5G Testbeds and Trials Programme, part of the DCMS, is exploring the benefits and challenges of deploying 5G with the aims of accelerating 5G deployments and maximising the benefits and opportunities of 5G for UK businesses.
[76] DCMS, £28 million to trial innovative new uses of 5G to improve people's lives, 13 January 2021 [accessed 7 December 2021].

mobile operators stands at 7, although a number of others are in the pipeline or at a trail stage. A number of these are operated on 5G, or a mix of 5G and 4G, although some are operated as 4G only networks.

Non-mobile operator players are also able to access mobile spectrum to provide services, and there is significant activity underway across a variety of players. They range from mobile equipment vendors, to system integrators and specialist ICT providers, all offering solutions to support digital transformation of industries.[77] Although we have not tracked all this activity for this report, Ofcom has issued more than 550 shared access licences since new rules were introduced in 2019, of which around half can be considered as supporting private network type solutions.[78]

Coverage of 4G, 3G and 2G remains largely stable, and extensive, but differences between urban and rural areas endure

Availability of mobile calls and data services

In this section, we continue to report on the availability of voice calls and data services across a range of metrics, as we have done in the past. This year, we are placing a particular focus on the range of 4G coverage available from individual MNOs, as this most closely matches the experience of most consumers. We continue to report on other metrics, including where all operators, or any one operator has coverage, both here but also in more detail in our online datasets.

The mobile coverage figures provided are based on predictions which the MNOs supply to Ofcom, with Ofcom undertaking regular testing to ensure the predictions provided are suitable for national and regional reporting. We take the accuracy of the data supplied to us seriously and we continue to monitor, through drive testing, the accuracy of all operators' coverage predictions. We note that operators continue to update and improve their prediction models and we continue to work with them to ensure appropriate validation is undertaken.[79]

Coverage outside premises remains high

As with last year, individual operators provide good 4G coverage outside more than 99% of UK premises.[80] In addition, c98% of premises have outdoor 4G coverage from all MNOs. Individual MNOs each provide coverage for outdoor voice calls in the vicinity of more than 99% of premises, whilst 99% of UK premises have coverage for outdoor voice calls from all MNOs.

Differences remain between coverage in urban and rural areas. Individual operators' 4G coverage outside of rural premises ranges between 93-97%, whereas each MNO serves more than 99% of

[77] There are also ongoing developments amongst cloud service providers. Amazon has recently announced a new 5G private network service, while Google and Microsoft have also entered into different partnerships internationally with telecommunications providers over the last 12-24 months.
[78] More information about the shared access approach is available on our website.
[79] In last year's report, we noted that new predictions had been received from O2 and that validation was ongoing. O2 has shared further data with Ofcom over the last year and is continuing to undertake work in this area.
[80] By coverage outside a premise, we mean coverage is predicted in a 100x100m area in which a dwelling is located, which can be seen as a proxy for outdoor coverage of populated areas.

urban premises. Outdoor voice coverage around rural premises ranges between 97-99% across MNOs, rising to more than 99% from each MNO for urban premises.

Coverage inside premises also remains high, with alternative solutions available for hard to serve locations

The coverage people receive indoors depends on a range of factors including: the thickness of walls, building materials used in construction and where in a building people are using their phone.[81] Consequently, there may be differences between operators' predicted indoor coverage data and the actual coverage available in some premises.[82]

For indoor 4G coverage, we find that the percentage of premises served ranges from 90-95% across the MNOs, with no substantive changes from last year. The availability of indoor voice calls is estimated to remain stable, ranging from 96-99% across the MNOs.

As with coverage outside premises, we continue to see a significant (and unchanged) difference between rural and urban areas for indoor coverage. Individual MNOs provide indoor 4G coverage to 69-80% of premises in rural areas, compared with 94-98% of urban premises. Indoor voice coverage is somewhat higher, ranging from 80-96% across the MNOs for rural premises, compared to a range of over 98-99% for urban premises.

Where indoor coverage remains poor, a number of alternative options are available to improve the experience. Tools include broadband-based calls on services such as Skype/WhatsApp, femtocells and Wi-Fi calling (the ability to make and receive a call and texts/SMS over a Wi-Fi network).[83] All UK MNOs offer Wi-Fi calling to consumers (though not all mobile phones are configured to support this feature). The percentage of calls made using voice over Wi-Fi by MNOs has remained relatively stable overall, between 2% and 16% per MNO (compared with between 2% to 18% in 2020).[84]

In addition, this year Ofcom has decided to expand the range of static indoor mobile repeaters that people can install themselves, without a licence. Such devices can boost the signals between a network operator's base station and a mobile phone, and so improve access to mobile services indoors. The new regulations will now allow 'provider specific' and 'multi-operator' repeaters to boost the signals of more than one MNO at a time, as long as they meet technical requirements.[85]

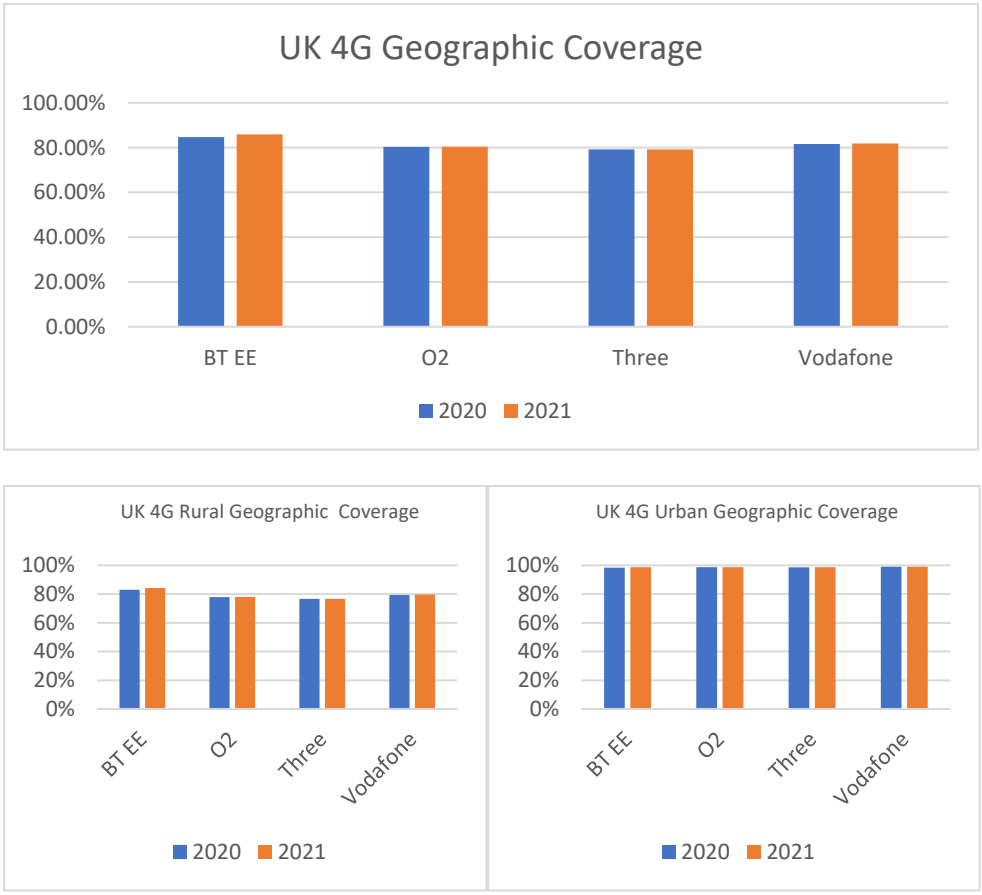
[81] Our online coverage checker provides additional information on the likelihood of there being indoor coverage in buildings at different locations and some of the factors that can affect a mobile signal indoors.
[82] We determine indoor coverage by applying an average building entry loss of 10dB across buildings. We acknowledge that this approach provides only a simplified view of what levels of indoor coverage might be, with the real experience in a building depending heavily on the types of building material and insulation in a given premises.
[83] We note that many of today's femtocells rely on 3G, and consequently some MNOs are placing less emphasis on this as a tool for improving indoor coverage.
[84] There are two types of Wi-Fi calling solutions: "cellular preferred", where the devices use Wi-Fi calling only if there is poor cellular coverage, and "Wi-Fi preferred" where all the calls are made via Wi-Fi, when Wi-Fi is available. This year, we have seen some of the UK MNOs move or revert to a "Wi-Fi preferred" solution.
[85] Ofcom, Statement: Mobile phone repeaters, 4 November 2021.

Geographic coverage remains largely stable, with slight improvements in the reach of 4G services

Although we continue to see limited year on year changes in geographic coverage percentages, some incremental improvements by individual operators have taken place.

From the data reported to us, we can see that all operators' coverage levels are slightly higher than those found in September 2020. BT EE has increased its 4G geographic coverage by c1 percentage point to about 86% of the UK, the most of any MNO. For other MNOs these increases are not observable as a percentage of the landmass.[86] Consequently, the UK landmass covered by individual MNOs ranges from 79-86%. Since the majority of the UK landmass is rural, rural coverage is closely aligned with these levels, with significantly higher urban geographic coverage.

Figure 22: UK geographic coverage, broken down by total UK, rural and urban geographic areas



Source: Ofcom analysis of MNO predictions, September 2020 and 2021.

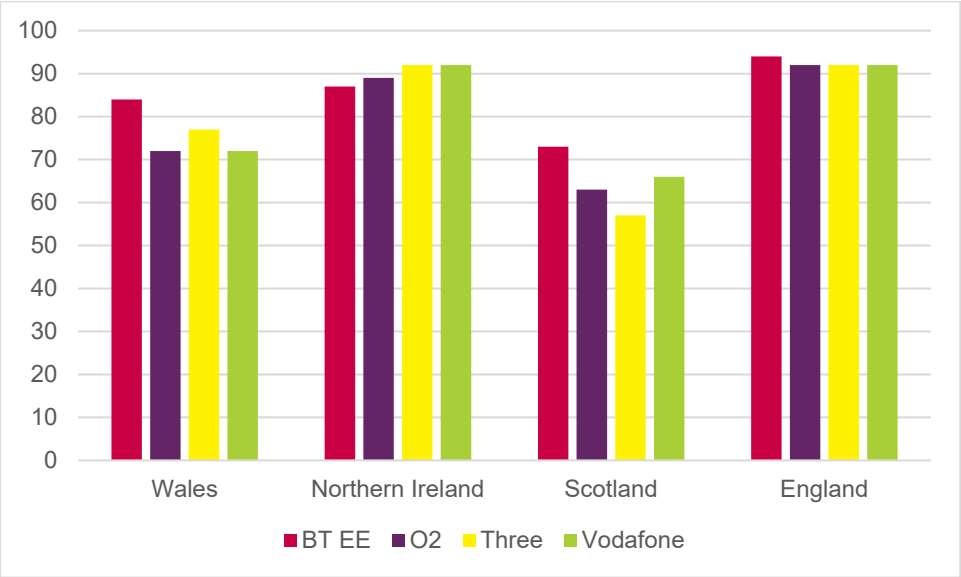
Differences across the UK nations

There continues to be significant differences in geographic coverage across the UK nations, although progress is also observable in each. As of September 2021, MNOs provided 4G geographic coverage ranging from: 92-94% in England; 87-92% in Northern Ireland; 57-73% in Scotland; and 72-84% in Wales. Coverage increases from BT EE mean that the top end of these ranges increased by 1

[86] As this would equate to c2500km2 of coverage, smaller increases may still reflect real improvements for some locations.

percentage point for England and Wales, and 2 percentage points in Scotland, alongside a 1 percentage point increase to the lower bound for Northern Ireland compared with last year.[87]

Figure 23: Differences in 4G geographic coverage in Wales, Scotland, Northern Ireland and England



Source: Ofcom analysis of MNO predictions, September 2021.

Initial SRN deployments are underway, although on the ground delivery remains at an early stage

The Shared Rural Network (SRN) project was agreed between the UK Government and the UK mobile operators in March 2020, as a key plank in improving UK mobile coverage and to support the Government's ambition of achieving 95% coverage of the UK landmass by 2025. Under the agreement, each MNO committed to reaching 88% coverage of UK landmass by 2024, and 90% of the landmass within 6 years from 2020 (subject to certain conditions), with an expectation that this will see the 'at least one operator' footprint reach 95% of UK landmass by 2025.[88] Ofcom is responsible for assessing operators against the 88% and 90% targets (including specific targets for each UK nation), which have been added to spectrum licences to make them binding.

2021 has seen MNOs begin to make progress towards the 88% target, which they are delivering though their own investment. As noted above, whilst this has crystallised in a percentage coverage point gain for BT EE alone, we have observed small increases from other MNOs. In 2020, we were only able to report a single early deployment as part of this commitment. Today, we can report that 46 fresh sites have so far been deployed to deliver on SRN commitments across all MNOs.[89] This includes 24 sites in England, 17 in Scotland and 5 sites in Wales.

[87] We also note that some areas without coverage are very remote - for example, 20% of Scotland was considered 'wild' by Scottish National Heritage. See Scottish Natural Heritage's (now NatureScot), Advice to Government, 16 June 2014.
[88] We note that MNO licences were amended in July 2021 to change the subsequent coverage deadline (relating to the 90% target) to January 2027. This reflects changes made to the Grant Agreement between the four mobile operators and Government in light of the current process for subsidy control.
[89] Other sites have been built over this period, which were in planning at the time of the SRN agreement and are not included in this figure, although they will provide significant coverage towards final SRN outcomes.

A key objective of the programme announced in March 2020 was a reduction in the number of partial not spots consumers experienced, where service was available from one MNO but not others. Since then, we have seen a two-percentage point decline in partial not spot levels, as parts of the UK begin to experience a more comprehensive service across all MNOs, as shown in Figure 24 below.

Figure 24: Partial Not Spots, Complete Not Spots and Full Coverage

	2019	2021
Complete Not Spot	9%	8%
Partial Coverage	25%	23%
Full coverage (All 4 MNOs)	66%	69%



Source: Ofcom analysis of MNO predictions.

Work to deliver the additional elements of the SRN that will secure the 90% and 95% coverage outcomes remains at an earlier stage. Component parts include deployment on the Extended Area Service (EAS) sites being built by the Home Office as part of the Emergency Services Network (ESN)[90], and the delivery of an additional 1% coverage in Total Not Spots (TNS) from sites shared by the 4 MNOs. In July, the Government completed its consultation on the target areas for investment, whilst the MNOs collectively published more localised plans highlighting areas likely to benefit from the programme.[91] Work to deliver this TNS commitment is continuing and remains focused on more detailed planning and procurement activities. We expect that the year ahead will see an increase in on the ground activity, although the planning and build lifecycle may mean more time is needed for coverage benefits to flow through.

Roads

4G coverage is predicted to be available inside vehicles on motorways and A roads in a range between 82-88% across the MNOs. This falls to 72-77% for B roads. Outside vehicles, 4G coverage ranges between 93-98% across MNOs for motorways and A roads (up 1 percentage point from last year for both Vodafone and BT EE), and 89-94% for B roads.

In-vehicle mobile voice services range from 90-97% of UK motorways and A roads across the MNOs. This falls to 80-91% of B roads. Voice calls outside vehicles on motorways and A roads remains stable, ranging from 98-99% across the MNOs, with voice calls outside vehicles on B roads ranging from of 94-97% across the MNOs.

[90] The Emergency Services Network (ESN) is a government programme to replace the current Airwave service used by the emergency services in Great Britain and transmit voice, video and data across a 4G network.
[91] Shared Rural Network, Forecast Coverage Improvements by Region [accessed 7 December 2021].

Rail

To gain a better understanding of the mobile signal on train routes, in 2019 Ofcom undertook a measurement campaign in partnership with Network Rail.[92] This highlighted that whilst predictions may indicate there is a good level of mobile signal present in the vicinity of rail corridors, this may not translate into a good experience on the ground because of the very specific challenges for mobile signals reaching into railway cuttings (on top of the challenge of getting the signal inside carriages).[93]

Given these challenges, solutions often require track side access, and so are not something MNOs can easily pursue on their own. Consequently, the last year has seen a number of significant announcements that reflect continuing efforts to address the challenge of delivering a service on-board trains across private and public sector players.

Case study: mobile coverage underground

In June, Transport for London announced it had agreed a 20 year concession with BAI communication to enable mobile coverage across the tube network. With 4G already available in parts of the network, this new plan means all stations and tunnels are expected to have coverage by the end of 2024.

The initial operational solution includes a Distributed Antenna System to provide connectivity along tracks and in ticket halls. It is forecast that more than 2,000 kilometres of cabling will be needed to deliver this, with an anticipated £1bn investment from BAI. As a neutral host model, BAI will provide the infrastructure and it will depend on commercial agreements with operators to provide seamless connectivity to consumers.

Meanwhile in Scotland, 5G RailNext, a Cisco led public and private consortium, undertook trials on Glasgow's Subway, with funding from the UK Government's 5G testbed programme, to explore the potential opportunities for 5G in busy underground environments.

[92] Ofcom, Mobile signal strength measurement data from Network Rail's engineering trains: information about the data files, 20 December 2019.
[93] For more detail on technical challenges in improving rail coverage see the report by Arup Alliance for the Department for Transport (Arup Alliance, April 2021, Mobile Connectivity in rolling stock – radio frequency attenuation characteristics.

Activity is also ongoing across several mainline routes. Another concessionary model was announced in March by Network Rail across the 51 miles of the Brighton Mainline, with Cellnex committing to provide mobile reception and fibre services across a 25 year period.[94] In the same month Network Rail and South Western Trains announced a new approach with Evo-Rail to deliver 'rail 5G' across 70km of track by 2025 (and starting this year) based on very high frequency Fixed Wireless Access providing track to train connectivity.[95] Other developments include announcements by BT EE of 65 new sites and 35 upgrades to improve rail connectivity across London, and a £45 million investment from Avanti to support a mix of upgrade and new build work across 200 sites and improved WiFi delivery along the West Coast Mainline.[96]

Emergency calls remain stable, with mobile increasingly used as a backup for fixed services

As we have explained in section one, traditional landline services are being retired and in future all fixed voice services will need to be delivered over broadband connections instead. However, in the event of a power cut, voice over broadband connections will not work, and therefore some fixed broadband providers are using mobile to provide backup services.[97] This increases the importance of indoor mobile coverage for emergency calls in the event of a localised power cut.

There are long standing arrangements that mean that a mobile handset making an emergency call will be able to do so through any network that is present, even if it is not the network the handset user subscribes to. Calls can also currently be made over 2G, 3G and 4G (via VoLTE) meaning that emergency calls are predicted to be possible inside almost all UK premises and across more than 95% of the UK landmass.[98]

On roads, emergency calls should be possible within vehicles for around 99% of motorways and A roads and 96% of B roads, rising to 99% of B roads outdoors (no change from last year).

We note, that as some network operators begin to consider reducing their 3G (and potentially 2G) deployments (see below), there may be a growing importance to the ability to roam onto another network to make an emergency call via VoLTE. Currently two of the UK's four MNOs offer emergency calling via VoLTE, with others relying on circuit switched fallback. More than 700,000 emergency calls were made via VoLTE in June 2021. Ofcom is monitoring the plans of the MNOs with regard to delivering emergency calling over VoLTE, including roaming onto other networks when necessary, to ensure there is no degradation in access as 3G and 2G services are withdrawn.

Switch off of 3G and (eventually) 2G services is on the horizon, and will need careful management

Over time, as 4G and 5G services reach an increasing number of households and businesses across the UK, mobile operators will be switching off their older 2G and 3G networks.

[94] https://www.cellnextelecom.com/content/uploads/2021/03/20210316-PR-Cellnex-UK-awarded-25-year-Network-Rail-contract-to-provide-connectivity-along-the-Brighton-Mainline-route_EN.pdf
[95] https://www.globalrailwayreview.com/news/119684/evo-rail-firstgroup-rail-5g/
[96] https://www.ispreview.co.uk/index.php/2021/05/ee-uk-boosts-mobile-coverage-across-londons-rail-network.html
[97] We discuss this further in the Network Security and Resilience chapter of this document.
[98] VoLTE meaning voice over long term evolution or 4G.

2G and 3G services first launched in the 1990s and 2000s respectively and while they continue to be important mobile services now, in coming years factors such as increasing operating costs and less efficient utilisation of spectrum and energy compared with newer generation technologies, are likely to result in the reduced use and eventual switch off of these networks.

Switching off these networks impacts a number of applications such as availability of mobile telephone calls, which rely on these legacy services. In addition, emergency voice calls and other applications such as smart meters and e-call services, could be impacted without careful implementation.

As things stand, the number of mobile sites where 2G and 3G is carried remains stable, with only a small reduction in the number of 3G sectors compared with 2020, as a result of spectrum being refarmed to other technologies.[99] This is in line with our expectation that typically 3G networks will be switched-off ahead of 2G networks. 4G services are now at a level of maturity where they can outstrip the data carrying capability of 3G in most places. However, based on data provided to us by MNOs, we estimate that more than 4m active devices continue to rely on 2G and 3G communications.[100] 2G will remain important, particularly for making voice calls, until more customers upgrade to 4G handsets.

Some MNOs are beginning to announce plans to switch off their 3G networks. For example, BT EE announced in July that it plans to phase customers off 3G by 2023.[101] The Government also announced on 8 December that mobile operators have confirmed that they do not intend to offer 2G and 3G mobile networks past 2033 at the latest.[102] Some operators will switch off their networks earlier than this date, and will announce their own plans, as BT EE have done.

We welcome the Government's commitment to work with network operators to ensure a smooth transition that meets the needs of consumers. It is important that as MNOs start to switch off these networks, adequate mitigation is in place to minimise the impact on users, including both customers with handsets and business users with systems reliant on 2G and 3G SIMs for IoT type communications.

Investment

Expenditure on mobile telecoms network infrastructure increased to £1.8bn in 2020

Data collected from providers shows that £1.8bn was invested in UK mobile network infrastructure in 2020, a £0.4bn (25%) real-term increase compared to 2019. In addition to this, £0.6bn was invested in infrastructure that is used to provide both fixed and mobile telecoms services in 2020.

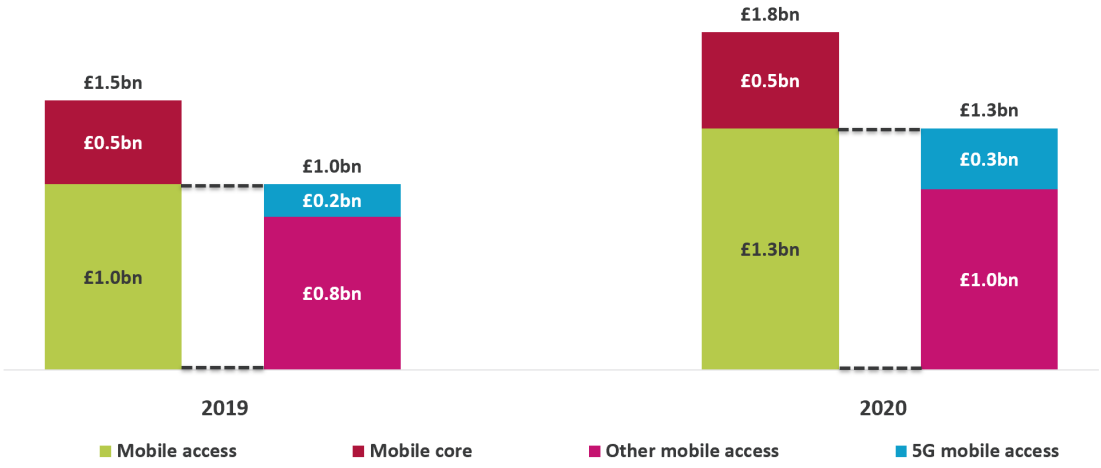
[99] Each technology on a mobile site may operate on several frequencies, and these can be divided into sectors (often three, but sometimes more), so there are many more sectors than sites.
[100] Based on aggregation of operator data supplied for June 20201.
[101] https://newsroom.bt.com/ee-to-offer-5g-solutions-across-the-entire-uk-as-bt-group-unveil-new-mobile-and-convergence-ambitions
[102] https://www.gov.uk/government/news/a-joint-statement-on-the-sunsetting-of-2g-and-3g-networks-and-public-ambition-for-open-ran-rollout-as-part-of-the-telecoms-supply-chain-diversificatio

Of the total mobile investment, £1.3bn (over 70% of the total) was investment in mobile access network infrastructure (including site acquisition, equipment and electronics). This was up by £0.3bn (30%) compared to 2019. The remaining £0.5bn was spent on mobile core and backhaul networks.

All four mobile network operators deployed 5G network infrastructure in 2020, when investment in 5G access networks totalled over £330m. This represented an increase of more than £150m (88%) compared to 2019.

Further information on how these figures have been compiled can be found in footnote 44 on page 21.

Figure 25: Mobile telecoms network capital expenditure: 2019 and 2020



Source: Ofcom / operator data. Note: Adjusted for CPI (2020 prices).

Adapting to the impact of Covid-19

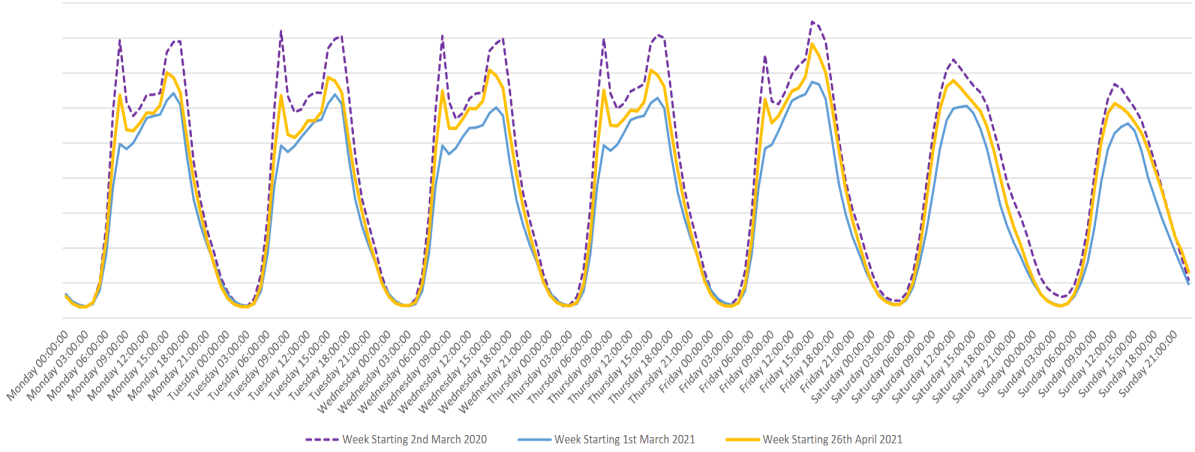
Last year we highlighted how mobile networks successfully adapted to the changing demands placed on them by Covid-19, as people came to rely ever more heavily on electronic communications services through periods of public health restrictions. In particular, we noted a shift in traffic from urban to more suburban areas.

This year we have found that some of the oscillations in network impacts resulting from changing consumer behaviour have smoothed out somewhat, but that for now at least some changes have become more enduring.

Operators continued to experience reductions in call handover volumes as new restrictions were introduced in January 2021, with commensurate increases as restrictions eased in April and May. [103] However, one operator found that user mobility was still significantly below pre-Covid 19 levels even as these restrictions eased, with more activity remaining in residential areas and city centre handover activity remaining at much lower levels.

[103] Call handovers occur as a user moves around and one site takes over from another as best placed to handle the call, usually based on proximity. As such, call handovers are a good indication of the overall mobility levels of a user base across areas.

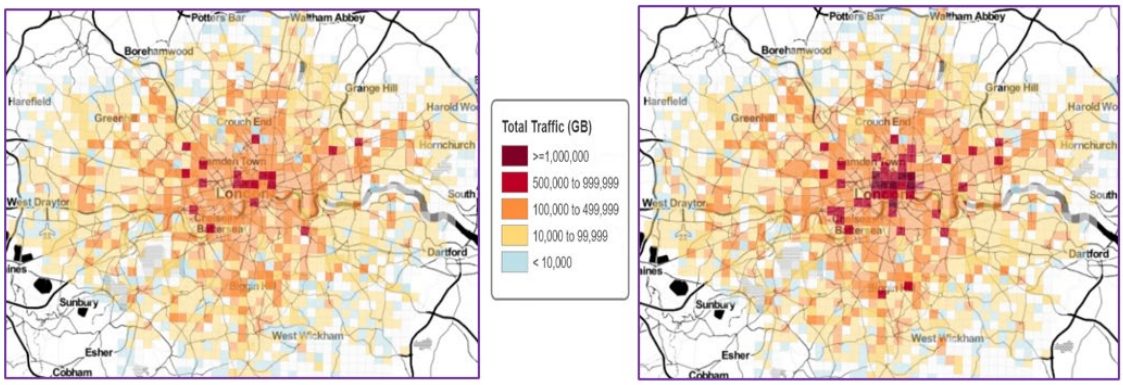
Figure 26: Call handover volumes between mobile cells for one operator, prior to the introduction of-Covid-19 related restrictions, and at two stages when restrictions were being eased



Source: confidential operator

Nevertheless, we have seen in our own analysis that traffic is to some degree returning to urban cores, with a significant increase in traffic volumes in dense urban areas such as central London, shown in Figure 27, below. This reflects a combination of the general increases in data consumption, as well as greater footfall in these areas over the 2021 measurement period.

Figure 27: Traffic density in London 2020 (left) vs 2021 (right)



Source: Ofcom analysis of operator data, June 2020 and May 2021.

One associated consequence of Covid-19 was an increased emphasis on UK holidays, which also led to increased demand in certain rural locations. Operators adapted to this change by deploying new sites and upgrading capacity to support increased consumer activities in these areas. As a result, some operators fast tracked key coastal towns for significant capacity upgrades, with at least 80 new deployments reported.[104] This should result in enduring improvements in service in these locations.

[104] Based on responses from two MNOs.

Mobile traffic

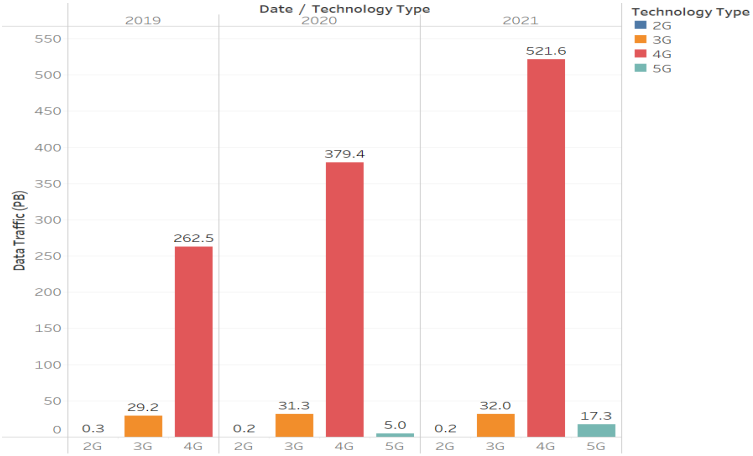
Mobile traffic continues to grow, with 5G making only modest inroads on the share carried by 4G

Mobile traffic continues to experience significant year on year growth, with the dominant share continuing to be carried across 4G networks.

From 2020 to 2021, we have seen an increase in our sample of total monthly data consumption of around 37% year on year, compared with a 42% increase from 2019 to 2020.[105]

4G traffic continues to predominate, representing 91% of all traffic (no change compared to 2020). 5G traffic is increasing more rapidly, and has grown from 5 petabytes (PB) to over 17 PB over the last year, a growth rate of 240%.[106] However, it continues to play a small role in absolute terms, representing only 3% of all traffic. 3G and 2G have seen negligible growth, and remain stable.

Figure 28: Monthly mobile traffic by technology, 2019-21



Source: Ofcom analysis of operator data (May 2019, June 2020, May 2021).

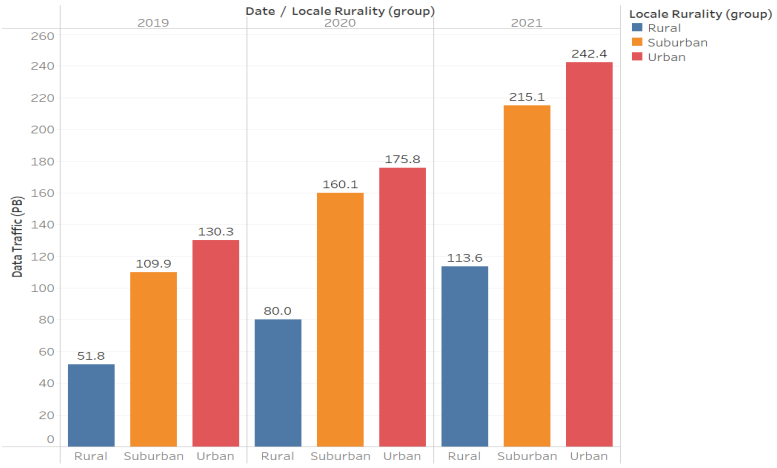
Data consumption continues to be divided between urban and rural areas in a way which largely reflects population distribution, rather than any significant difference in data consumption of a typical user in rural areas when compared.

This year we observe some small fluctuations, with a marginal increase in the share of data consumption in rural areas (almost 20%, up from just above 19%), while urban and suburban areas represent 80% of mobile data traffic.

As urban and suburban areas represent the majority of data use, its growth rate is closely tied to the national picture, up 36% on last year. In relative terms, it can be seen that rural usage continues to grow more rapidly (from a much lower base), up 42% on the previous year.

[105] Whilst this appears a slight decline in growth rate, we collected last year's data in June, and this year's data in May, suggesting a broadly equivalent growth rate overall.
[106] 1 PB is equivalent to 1,000,000 GB.

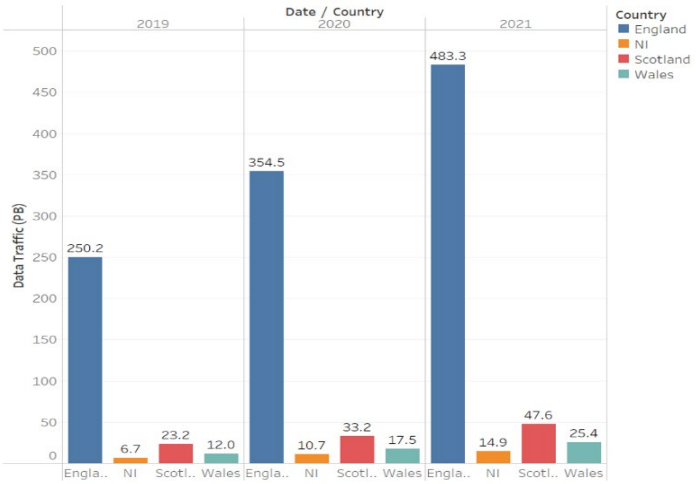
Figure 29: Monthly mobile data traffic in rural, suburban and urban areas, 2019-21



Source: Ofcom analysis of operator data (May 2019, June 2020, May 2021).

The relatively higher growth in rural data consumption, and different starting points, means that data growth looks different across the 4 UK nations. Whilst data traffic in England grew at 36%, just below the national average, and Northern Ireland saw growth of 39%, just above it, growth in Scotland and Wales was between 43% and 45% year on year.

Figure 30: Monthly mobile data traffic by UK Nation, 2019-21

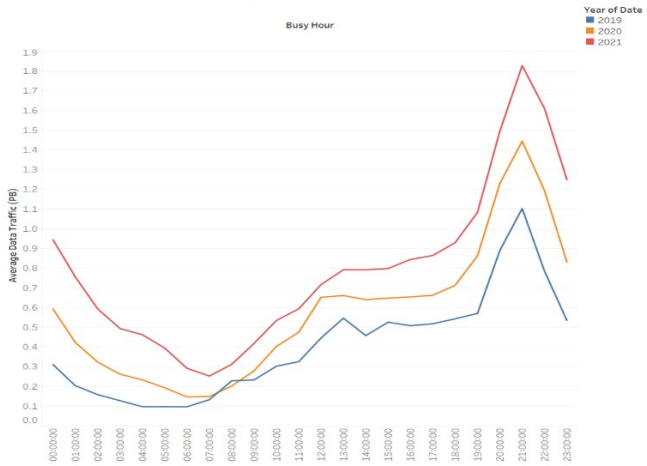


Source: Ofcom analysis of operator data (May 2019, June 2020, May 2021)

Mobile use in the home also continues to play an important part in traffic generated across the network, with our analysis showing that the mobile busy hour for data traffic continued to occur around 9pm, (in line with previous findings) at a time when restrictions remained on typical evening leisure activities.[107]

[107] Last year, we highlighted related analysis showing a significant decline in the number of sites experiencing their busy hour in the early morning, and an increase in sites which had their busy hour during the day and into the evening, as public health restrictions were introduced. Here we have instead focused on the cumulative busy hour traffic from sites whose busy hour falls within a given one hour window, showing that even as busy locations changed (as per previous analysis), overall traffic consumption trends and times of use have remained quite stable, apart from a small dip in morning rush hour consumption in 2020.

Figure 31: Mobile busy hour (daily average) calculated as traffic per sector at each sector's busiest hour



Source: Ofcom analysis of operator data.

As shown in Figure 31 above, traffic has increased substantially over the evening peak, up more than 25% on the last year from a level already well above typical day-time traffic. This aligns with wider trends also witnessed with fixed broadband traffic in the previous section, where we also highlighted the growth in fixed traffic during the already busy evening period over the last year.

Internet of Things

There has been a significant increase in the number of Internet of Things devices

The Internet of Things (IoT) refers to a network of devices and sensors capable of collecting and sharing data with humans or with other devices, and taking actions based on this. Operators use IoT and Machine-to-Machine (M2M) networks for a range of applications, including smart meters for utilities[108], travel and transport, environmental sensors and energy management solutions for smart buildings, car telemetry, video surveillance and pipeline monitoring for oil and gas companies. This year's report continues to provide qualitative and quantitative insights into public and private wide-area IoT networks.[109]

IoT Connectivity available from Mobile Network Operators

Low-power wide area networks (LPWAN)

Wide area IoT connectivity can be delivered via several technologies: traditional cellular (2G, 3G, 4G and 5G) and Low-Power Wide Area (LPWA) networks such as Narrowband IoT (NB-IoT), Long Term Evolution for Machines (LTE-M), Long Range Wide Area Networks (LoRaWAN) and Sigfox. NB-IoT and LTE-M have been standardised by 3GPP and they are now part of the 4G standard.

[108] Arqiva Limited provides radio communications links between the smart meters and the energy suppliers in Scotland and the north of England while O2 provides the radio links in the rest of England and Wales.
[109] IoT can be delivered via other tech such as Wi-Fi, Zigbee, Bluetooth and several others. In this report, we focus only on IoT services delivered through traditional cellular technologies by MNOs and LPWAN technologies such as NB-IoT, LTE-M, Sigfox and LoRa.

LPWA technologies are designed for IoT applications and services that have low data rates, require long battery lives and can operate in remote and hard to reach locations. Furthermore, their extended range makes them better suited for in-building applications such as smart meters and smart car parks which may be located underground or in basements.

Today, IoT connectivity is delivered by UK MNOs using a mix of cellular technologies (2G, 3G, 4G and 5G) and Low Power Wide Area Networks (LPWANs) such as NB-IoT and LTE-M. Vodafone continues to provide NB-IoT coverage across the UK. While O2's LTE-M coverage remains available only in the eastern parts of the UK, it has now started offering commercial services on the network. BT EE is exploring proof-of-concept deployments using LoraWAN.

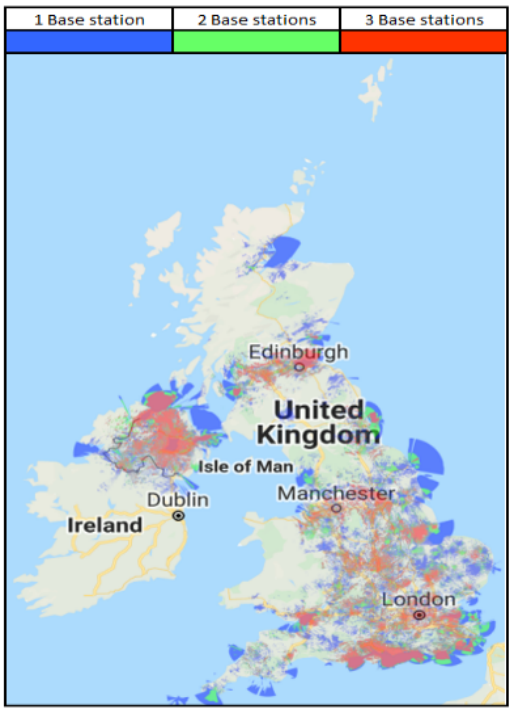
This year, the number of active IoT connections on MNO networks increased by 63% (more than double the year-on-year growth from last year) to 10.3 million. Although the overall volume of IoT data traffic across all UK MNOs increased by 55% to 1.26PB, it remains significantly less than 1% of overall data traffic.

IoT Connectivity available from non-mobile network operators

Sigfox

Within the past year, WND UK - the sole Sigfox network operator in the UK - has focused on developing a cost-optimised network that supports very low bandwidth applications with infrequent transmissions such as telemetry, metering, asset tracking, gas and water leak detection. Its network includes more than 1500 base stations, with population and landmass coverage of 83% and 54% respectively. Figure 32 below shows the coverage of WND UK's network, distinguishing between areas where more than one base station is providing service for increased reliability.

Figure 32: Map of WND UK's Sigfox coverage



Source: WND UK.

Public LoRaWANs

Public community LoRaWAN networks, which are open-source and largely free to use, allow users to connect devices to existing gateways (base stations) or add new gateways to increase overall coverage.[110] [111] They support developers, small and medium businesses and enterprises (particularly for Proof-of-Concept), government and public initiatives across the UK. Today, The Things Network (TTN) - one of the leading global providers of public LoRaWANs - has about 950 gateways in the UK serving 100 communities.

Private LoRaWANs

Private networks offer managed carrier-grade services with guaranteed availability, on a paid basis. We are aware of several private LoRaWAN providers operating in the UK, such as Comms365, Connexion, The Things Industries (TTI) and North limited. We estimate that these networks have at least 580 gateways (a 66% increase from the past year) between them serving about 37,000 devices (a 50% increase from the past year). Some of the services provided by these networks include intelligent lighting, smart building, flood and air quality monitoring, waste management solutions, soil moisture sensing and asset tracking.

IoT has the potential to play a growing role across a range of services

The increase in IoT devices and traffic suggests that businesses are increasingly utilising the services IoT can deliver.

As the Covid-19 pandemic has evolved, businesses are relying on a range of IoT devices to support the safe and secure return of employees to work. For example, some of these devices measure body temperature, building occupancy and social distance, with both Vodafone and Virgin Media O2 having launched suites of solutions for the delivery of such services.

The on-going PSTN switch-off planned for completion in 2025 has implications for a range of sectors which include domestic and business customers, with the potential for IoT to support enduring solutions in services such as security devices, telecare and utility network monitoring.

Businesses across various sectors and industries are also increasingly relying on IoT applications to support their sustainability goals. Remote monitoring and control of devices, for example, can enable businesses to reduce the need for human travel, thereby reducing their carbon footprint. Smart technology in cities (e.g. smart lights, smart bins and traffic management systems) could also minimise wastage and drive efficient use of resources and infrastructure.

There is an enabling environment for IoT to thrive in the UK

The increasing availability of 3GPP standardised technologies – such as 5G (Massive Machine-Type Communications or MMTC), NB-IoT and LTE-M – which are optimised for IoT applications, together with non-3GPP standardised technologies such as Sigfox and LoRaWan, support the continued adoption of IoT services.

[110] They are usually bound by fair use policies which restrict, for example, data rates, packet sizes, transmit time, and number of gateways/devices.
[111] The network servers are hosted by not for profit institutions like the Digital Catapult (UK) or companies which also offer private networks.

One historic obstacle has been the potential security limitations in certain consumer IoT devices, which in many cases have universal default passwords and are not updated against known security threats. However, in the UK, government has set out its intentions for proposed legislation to regulate the cyber security of such products with the overall objective of ensuring a 'secure by design' approach in the future.[112]

Furthermore, Ofcom recently introduced regulations which harmonise conditions for spectrum use by Short-Range Devices within the 870 to 874.4 MHz frequency bands.[113] These changes will make the band more suitable for IoT type applications such as smart metering and industrial automation. The decision also means the UK can benefit from economies of scale for IoT type devices which already operate in these bands in other territories.

[112] DCMS, Government response to the call for views on consumer connected product cyber security legislation, 21 April 2021.
[113] Ofcom, Statement: Decision on changes to the licence exemption for wireless telegraphy devices and on licensing equipment in 57 to 71 GHz, 29 April 2021.



Network security and resilience

Key highlights:

- Ofcom has been working closely with DCMS and the National Cyber Security Centre (NCSC) in preparation for the introduction of the Telecommunications (Security) Act, which will bring major changes to our existing regulatory regime.
- As part of providing a summary of network security & availability incidents reported to Ofcom this year, we identify the themes of the common causes of major outages. We highlight a trend of software related incidents impacting services for more customers and for longer periods of time compared to hardware and process/policy failures. Work to explore and address these causes is ongoing.
- The incidents reported to Ofcom this year do not suggest that the Covid-19 pandemic has resulted in a noticeable increase in telecoms outages, despite the increased demands on the networks.
- The landscape for resilience at customer premises is changing. New resilient broadband services have been launched which make use of 4G services as backup. Landline voice is evolving too. Engineering the new All-IP version of landline voice services securely and reliably remains important.

Security

New legislation will improve telecoms security and increase our role in monitoring and enforcement

In last year's report, we discussed the Telecommunications (Security) Bill[114] which DCMS had introduced at the end of 2020, with the objective of improving the security of the telecoms sector. The new legislation does this in two main ways:

- it imposes new, **strengthened security duties on public telecoms providers**, to be supported by detailed security regulations in secondary legislation, and technical Codes of Practice giving guidance on the measures to be taken. The Bill also gives Ofcom powers to monitor and enforce industry compliance with these duties and specific security requirements, and to impose financial penalties in the event that we find a breach; and

[114] Telecommunications (Security) Bill: overarching documents (gov.uk)

- it introduces new powers for the Secretary of State to set rules limiting the use of products and services provided by **High Risk Vendors (HRV)** where necessary in the interests of national security. Although not involved in its enforcement, Ofcom may be asked to monitor public telecoms providers' HRV usage.

The Bill has now become an Act, having received Royal Assent on 17 November 2021. The parts of the legislation related to HRV are now operational. It is expected that the DCMS Secretary of State will soon issue Designation Notices to some companies, which identify them as HRVs, and Designated Vendor Directions to some communications providers, which will set out restrictions and other requirements relating to their use of the equipment or services offered by companies which have been identified as HRVs. The Secretary of State may also then direct Ofcom to gather information from communications providers who have received a Designated Vendor Direction and report on their usage of relevant equipment or services.

The provisions in the Act relating to strengthened security duties, and Ofcom's new powers to monitor and enforce compliance with them, are expected to come into force in October 2022. Prior to this, the accompanying secondary legislation and any initial Codes of Practice will be consulted on and issued by DCMS. Ofcom will also consult on and publish procedural guidance, which will set out how we expect to exercise our functions under the new legislation. This will cover practical matters, such as arrangements for reporting security compromises and our approach to compliance monitoring.[115]

The new regime is a major change in the regulation of security in the telecoms sector. Providers are likely to have to make substantial improvements to their current security measures and processes to comply, and indeed this will be an ongoing process as security threats, and provider responses, evolve. It will also take time for Ofcom, using our extended powers, to build a detailed understanding of the security measures providers have in place, and to identify any compliance concerns. We will be including a summary of the extent to which providers are complying with their key security duties in future versions of this report.

Resilience

In the following sub-sections, we discuss the network and service affecting incidents reported to us by Communications Providers, as required under the Communications Act 2003. We highlight the trends of the reported incidents, which give an indication of the technology changes in the telecommunications landscape and how they impact networks and services.

We reflect on how residential connectivity and services resilience is changing, including the ability to make calls over mobiles and landlines, ongoing broadband and voice technology changes, and the resulting resilience approach for residential voice services.

We discuss how Ofcom has progressed work on network and service resilience in collaboration with industry bodies. We also discuss ongoing and future UK resilience initiatives related to the telecommunications sector.

[115] Until these provisions come into force, existing security duties under section 105A to 105D of the Communications Act 2003 and associated Ofcom guidance continue to apply.

Communications Provider incident reports

We have received reports from Communications Providers throughout the year describing the security and availability incidents that created a significant impact on their networks and services. We have published guidance for providers, explaining the types and sizes of incident we expect them to report to us in order for them to comply with their regulatory obligations.[116]

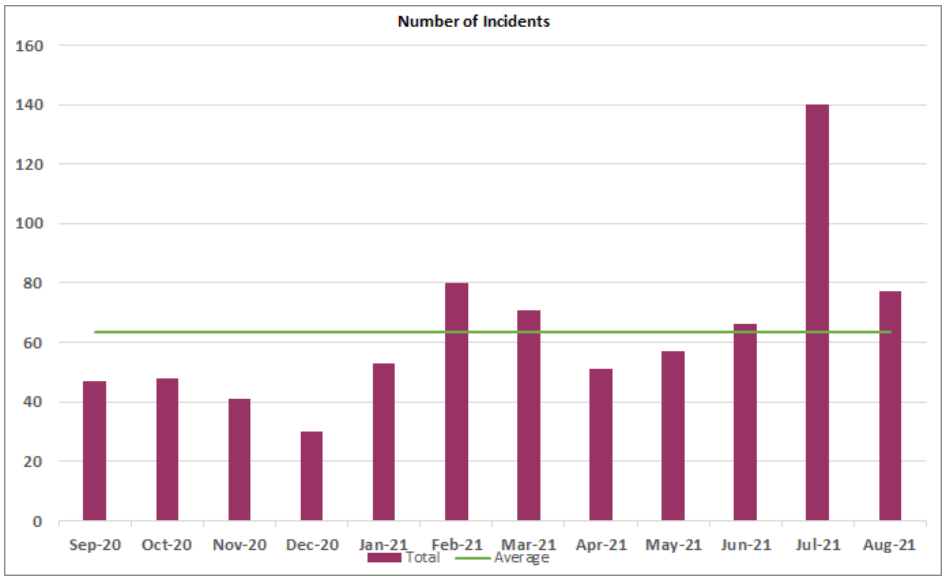
We received a total of 761 reports of relevant incidents from Communications Providers this year, and although this is an increase in the number of incidents reported in 2020 it is still within range of previously observed year-on-year variability.[117]

The number of fixed network incidents increased in relation to last year (426 in 2021 compared with 283 in 2020). The number of mobile network incidents reported was 335, which also represents an increase from the 249 mobile incidents that were notified in the previous year.

We have focussed on ensuring consistent reporting across both fixed and mobile operators in this period, and the increases identified above may be a reflection of progress in ensuring all relevant incidents are reported to Ofcom in line with our guidance.

The monthly breakdown of incidents in Figure 33 shows a degree of month-on-month variability as well as the average, which increased to 62 for 2021 from 43 in 2020. There were no obvious seasonal patterns with the exception of the single peak experienced during the summer months, which occurred in July this year.

Figure 33: Monthly number of incidents reported between September 2020 and August 2021



Source: Ofcom analysis of operator reported data.

[116] Ofcom, Ofcom guidance on security requirements in sections 105A to D of the Communications Act 2003, 18 December 2017.

[117] Note that our approach to incident reporting does not capture individual "line faults" in fixed networks affecting a single network connection. There is no evidence that there has been any significant change in this area, although, as fixed networks move away from copper to full fibre connections, they should reduce considerably.

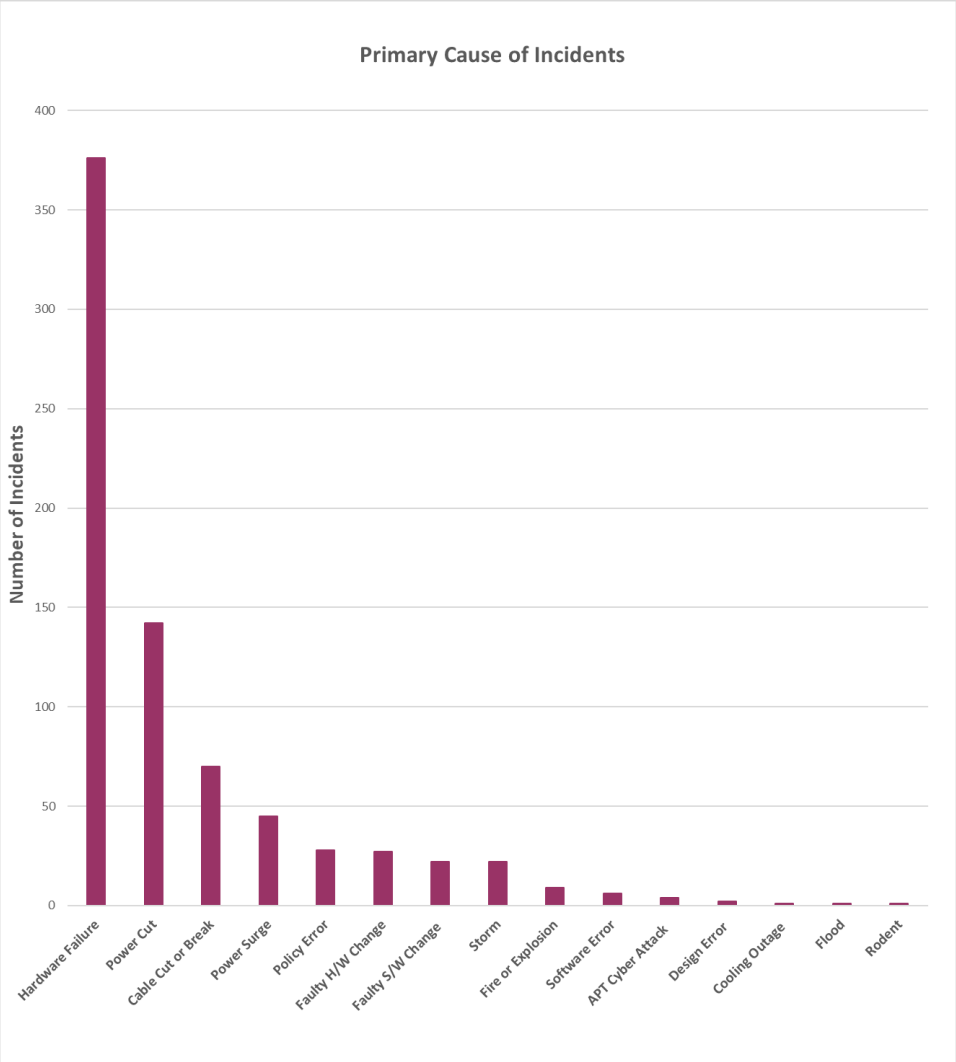
All networks have continued to cope well with the extended work-from-home period as a result of the Covid-19 pandemic. It is notable that despite the increased volume of traffic during this reporting period, including additional Covid-19 lockdown periods (with broadband traffic consistently 30% above average), we have not recorded any incidents directly attributable to changed working and behaviour patterns.

Equipment failure and power interruption remain the primary cause of incidents

During the previous reporting period, we changed the root cause categories used to classify the primary cause of each incident based on the information in the providers' reports. This has enabled a more granular approach to be adopted and has provided us with better information to understand the common factors behind a variety of incidents.

The most common causes of incidents are either hardware failures, cable damage or supply of stable power. The next group of incidents that occur most frequently are related to issues with change management processes or policy flaws within a Communications Provider's organisation. These are represented in the chart below.

Figure 34: Primary causes of incidents reported to Ofcom, September 2020 to August 2021



Source: Ofcom analysis of operator reported data[118]

In this reporting period we have particularly focussed on the Faulty Software Change category, as although the number of incidents is comparable with Faulty Hardware Change or Policy, Process and Procedure Errors, the hours lost by these incidents has been significantly greater as detailed in the following tables. The majority of these software incidents occurred in the first half of the reporting period, and we have worked with the relevant providers to address our concerns and have seen a reduction in both the number and impact of these events.

However, due to the disproportionate impact of these types of Incidents we will continue to work with the relevant providers and we may take action to review any further occurrence of these types of events using our information gathering powers.

[118] H/W – Hardware, S/W – Software, APT – Advanced Persistent Threat

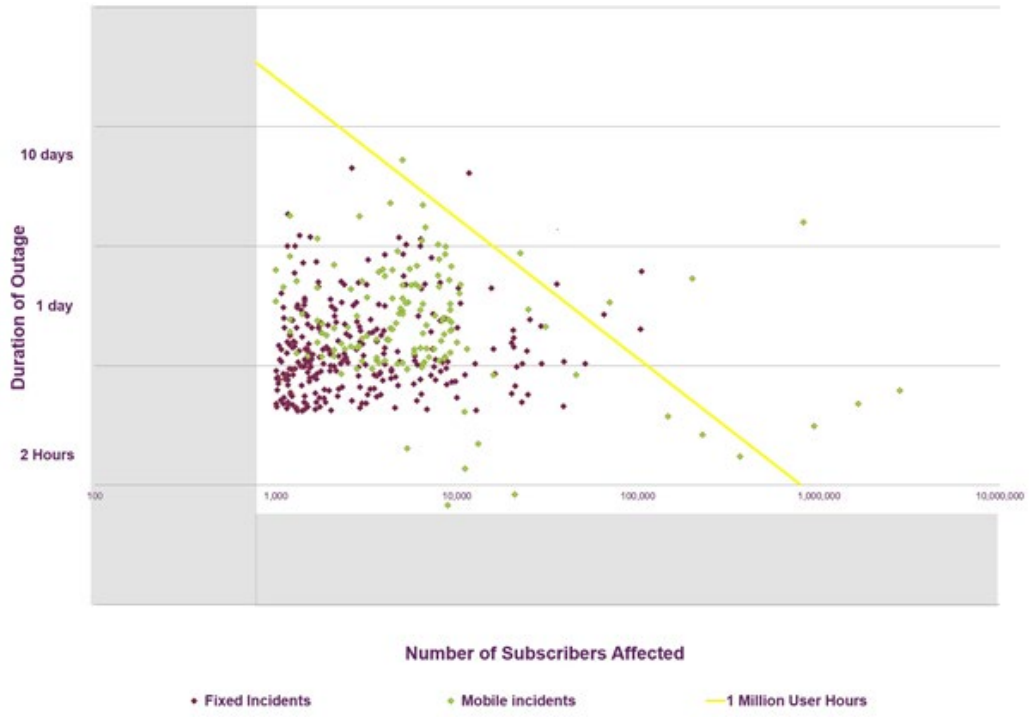
Figure 35: Users impacted / Service Hours lost by Hardware, Software and Procedural incidents

Type	Total Incidents	< 10K	10K - < 99K	100K - < 249K	> 250K
Hardware	27	20	6		1
Software	22	11	2	3	6
Process / Policy	28	23	5		

Type	Hrs Lost	< 1 Hr	1 - < 12 Hrs	12 - < 24 Hrs	> 24 Hrs
Hardware	5,663,726	2	19	5	1
Software	52,804,284	4	13	3	2
Process / Policy	759,131	2	23	3	

The new categorisation of faults not only allows us to better understand what is failing in providers' networks, but also to understand where in the architecture of the network a failure has occurred, and if there is any correlation between this and the scale of impact.

Figure 36: The impact of incidents reported between September 2020 and August 2021



Source: Ofcom analysis of operator reported data.

The chart above further categorises incidents by adding the duration of an outage to the number of users impacted. This provides a view of the total number of hours lost to users of the networks or services during an incident.

Each of the fixed and mobile points to the right of the yellow line indicate an incident that caused more than one million service hours to be lost for that incident.

Some of these incidents seem to be driven by "technology refresh" linked network transformation activities. We have aggregated our concerns under a number of themes below and set out how we have progressed our concerns with the providers involved.

We have progressed our work with industry on incident themes

Throughout the year, we have continued our work with communications providers to extend the correlation and analysis of incident themes. While there have been improvements within some of these areas as a result of the respective providers progressing mitigation actions, growth in the frequency and impact of events under other themes has also been observed:

- **Change management and testing:** as communications providers have continued their network upgrade or transformation activities during the period, we have seen an overall reduction in the impact of service-affecting events caused by poor practice in change management and testing. However, there are still a number of incidents caused by inadequate change management control, and some of these incidents have been attributable to the work that providers are conducting to prepare their networks for Network Functions Virtualisation (NFV). [119] We will continue to work with the affected providers to address this issue.
- **Mobile backhaul transport:** ongoing analysis of incidents affecting backhaul transport in mobile networks has confirmed that disruption at a single site continues to cause the loss of service availability at a large number of additional mobile sites. We will be considering use of our information gathering powers to ensure that the scope and scale of this issue are fully understood.
- **Fixed access and aggregation:** over the reporting period, exchange consolidation programmes have been implemented in coordination with FTTP deployments and we have started to observe single location incidents impacting significantly increased numbers of users. We will be considering use of our information gathering powers to obtain information on access and aggregation designs to identify any further impacts from the development of this trend. We may also consider guidance about what we consider to be appropriate levels of non-resilient concentration.
- **Interconnect:** the ongoing migrations from traditional PSTN & copper services towards fibre-only FTTP and fully IP-based services, along with new alternative FTTP access network provider rollout have increased the incidents affecting interconnect and other wholesale transit services. We will seek to work more closely with standards forums like NICC and industry groups such as the Comms Council UK to promote the adoption of best practice.

For all of the above themes, we will continue to analyse causes and mitigation actions so that they can be shared with other operators within each relevant sector. We will also seek to establish an industry working group to develop a trial procedure for the automated submission of incident reporting data.

[119] Traditional networks are evolving from Physical Network Functions to Virtual Network Functions based on cloud-native software principles, usually located within a provider's physical network estate. Network Functions Virtualisation across different technology domains (fixed, mobile, Wi-Fi, etc) presents convergence opportunities that allow further innovation and efficiencies.

Emerging customer premises resilience approaches

As technology changes and consumers and businesses become ever more reliant on communications services, providers are finding ways to enhance the resilience of their services.

Mobile backup for fixed broadband Internet:

Two providers have launched 4G mobile backup solutions to their fixed broadband Internet products. These services use enhanced capabilities of the broadband routers they supply to customers to automatically switch over to mobile access when a fault occurs on the fixed access connection.[120]

There is also standards work ongoing in the Broadband Forum Wireless Wireline Convergence group which could further develop such products to enable more seamless handover between, and the concurrent use of both fixed and mobile access technologies.

Landline voice

As set out in "*The UK's traditional telephone network is also being replaced"* on page *27*, BT and Openreach plan to retire BT's legacy telephony network and the wholesale services that underpin that network by the end of 2025. To ensure that landline voice services continue to be available, providers currently using the legacy telephony network will deliver landline calls using digital technology called Voice over Internet Protocol (VoIP) over the broadband connection, which is typically referred to as Voice over Broadband (VoBB).

In order to maintain a high quality, robust, and secure voice service, the largest consumer focussed communications providers have built their VoBB services entirely within their own infrastructure and securely separated it from the Internet. Such *non-Internet* VoBB services can be prioritised over the user's local area network (LAN) and the provider's access and core networks to ensure that it works consistently well during network congestion or on low-speed broadband connections and offers high levels of resilience.[121]

However, in the event of a power cut, customers using VoBB will lose the ability to make voice calls. Among other things, Ofcom guidance with regard to compliance with General Condition A3.2(b) provides that VoBB providers should provide at least one solution that enables access to the emergency services for a minimum of one hour in the event of a power outage.[122] The obligations in

[120] https://www.bt.com/halo and https://www.vodafone.co.uk/broadband/pro

[121] This assumes that the broadband service is functioning and that the customer's premise has power available to the broadband router which contains the VoBB client. Such services can be prioritised provided they meet the requirements for a 'specialised service' set out in Art 3(5) of retained Regulation (EU) 2015/2120 of the European Parliament and of the Council of 25 November 2015 laying down measures concerning open internet access and retail charges for regulated intra-EU communications and amending Directive 2002/22/EC and Regulation (EU) No 531/2012 (Text with EEA relevance).

[122] In addition: the solution should be suitable for customers' needs and should be offered free of charge to those who are at risk as they are dependent on their landline; providers should i) take steps to identify at risk customers and ii) engage in effective communications to ensure all customers understand the risk and eligibility criteria and can request the protection solution, and; providers should have a process to ensure that customers who move to a new house or whose circumstances change in some other way are aware of the risk

General Condition A3 and Ofcom's related guidance on them are technology neutral and providers are taking a variety of approaches to meeting the obligation, based either on offering battery back-up to the equipment delivering the service in the home, or relying on alternative connectivity over mobile networks. We will ensure that communications providers comply with these obligations as VoBB is rolled out.

Persistent attacks on Internet-based voice service providers

The UK community of smaller Internet-based "All IP" Voice Service providers have been subject to a persistent and sector-wide Distributed Denial of Service (DDoS) attack[123]; the objective of which has been to extort a fee from each of the operators who have been attacked, in order to secure relief from future attacks for a period of twelve months.

We have participated in an industry forum alongside Government and NCSC to support the response of the sector to this threat and we will continue to encourage the adoption of industry best practice to assist in mitigation.

Our work with the Electronic Communications Resilience & Response Group (EC-RRG) has continued

We have continued our work with the Electronic Communications Resilience & Response Group, known as the EC-RRG, and have contributed to updated *Resilience Guidelines for Providers of Critical National Telecommunications Infrastructure*[124] which were published in August 2021.

The updated guidelines include design and operations guidance for new areas such as Virtualisation and a methodology for the Measurement of Resilience as described in both ETSI and ITU publications. Criteria included in this methodology identified both service parameters and operational state.

The latest issue of the EC-RRG Resilience Guidelines has also identified design principles for resilience which include:

- Separation between Layers & Domains
- Redundancy for Systems & Paths
- Replication and Synchronisation of both Data and State
- Load Sharing and Balancing of Traffic

In the coming year, within the EC-RRG Resilience working group, we will collaborate with communications providers to encourage them to contribute their best practice design inputs to enhance or augment these design principles. We will also work with the group to ensure these

and protection solution available. For more information, see Ofcom, Guidance on General Condition A3.2(b) - Protecting access to emergency organisations when there is a power cut at the customer's premises, 10 October 2018.

[123] BBC, Cyber-attack hits UK internet phone providers, 26 October 2021.. Such attacks typically involve targeting network servers with high volumes of bogus messages from multiple sources so that services are degraded or fail completely.

[124] EC-RRG Resilience Guidelines for Providers of Critical National Telecommunications Infrastructure

principles can support the creation of a Resilience Assessment Framework - which will improve Ofcom's ability to assess and report on the resilience of the sector.

Our activities and guidance will adapt to the new legislative environment

Resilience and the Telecommunications (Security) Act 2021

The Telecommunications (Security) Act 2021 introduces significant changes to the Communications Act. It also changes the legislative framework in which broader network and service resilience is captured. Among other things, Ofcom will consult on and publish procedural guidance, which will set out how we expect to exercise our functions under the new legislation, including in relation to reporting security compromises, which encompass non-cyber-security aspects of network and service resilience. We will also review our existing guidance on security and resilience requirements[125] and consider issuing resilience guidance under the revised framework where appropriate.

Other network and service resilience issues

Reliability of Internet services

In addition to Incidents obliged to be reported to us, there were three incidents which were not subject to reporting requirements as they currently fall outside the scope of relevant Ofcom regulation, but which had a significant impact on the availability of services and applications used by the public. These incidents occurred in June and July of 2021:

- Fastly[126] - Content Delivery Network affecting Media, UK Government and Payment Websites
- Akamai[127] - Domain Naming Services affecting Banks, Gaming and TV Streaming Services
- Facebook[128] - Change Management issues affecting Messaging and Social Media applications.

Other UK resilience initiatives

- In May 2020 the National Infrastructure Council (NIC) published its report and recommendations on the resilience of specific sectors that support critical national infrastructure. It included a recommendation for the regulatory authorities of these sectors to develop resilience standards and report to Government on their effectiveness.
- Following the NIC Report, Government has identified the need for a National Resilience Strategy Review - and has already concluded a call for evidence for this strategy in September 2021. A number of the NIC recommendations informed the questions presented within the Call for Evidence, including the need for resilience standards. We will look to engage with the sector and Government on any relevant recommendations once they have been published in 2022.

[125] Ofcom, Ofcom guidance on security requirements in sections 105A to D of the Communications Act 2003, 18 December 2017.
[126] BBC, Websites begin to work again after major breakage, 8 June 2021.
[127] BBC, Major websites hit by global outage, 22 July 2021.
[128] BBC, Facebook, WhatsApp and Instagram back after outage, 5 October 2021.

Connected Nations update

Spring 2022

Connected Nations update: Spring 2022 – Welsh overview available

REPORT:

Publication date: 20 May 2022

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1. Overview

This is the first interim update to our December 2021 annual Connected Nations report. It is based on mobile coverage and fixed broadband availability across the UK as of January 2022.

Key findings

Number of homes able to get gigabit capable broadband is up to over 19.3 million homes (66% of all UK homes), up from 13.7 million (47%) since our last update. In December 2021, Virgin Media O2 announced that it had made its entire network gigabit capable, which accounts for much of this large increase.[1]

Full fibre coverage continues to increase at pace, up to 33% from 28% in the four months between September 2021 and January 2022, an increase of five percentage points, with just under 9.6 million homes now covered.

Superfast broadband coverage across the UK remains at 96%, with England, Northern Ireland and Wales all seeing an increase of one percentage point in superfast coverage.

The number of premises unable to get decent broadband, when factoring in fixed wireless and fixed line, has dropped from 123,000 to 99,500 premises since our December report and those unable to achieve decent broadband over a fixed line has dropped from 650,000 to 506,000 over the same period.

Mobile coverage remains stable and operators are beginning to roll out coverage to new areas through the **Shared Rural Network** scheme, agreed with the UK Government in 2020. As a result, nationwide coverage is set to increase in the coming years. 5G coverage is developing and we present some early coverage figures in the tables below.

As with previous updates, we have published dashboards and an interactive report that has both the latest and historical data.

We have also used the data in this report to update our broadband and mobile coverage checker.

Key findings – Fixed broadband

Gigabit capable broadband: availability of broadband capable of delivering Gigabit[2] speeds for consumers continues to improve at a rapid pace, with nearly 19.3 million UK homes[3] (66%) now able to access these faster services, up from 13.7 million homes (47%) reported in our December 2021 report. This has been driven by a combination of the continued rollout of full-fibre broadband and Virgin Media O2's network upgrade programme.

[1] Virgin Media O2, Virgin Media O2 completes gigabit upgrade in boost for Britain's broadband target, 7 December 2021.
[2] Gigabit capable networks include full fibre networks as well as any network that is able to offer at least 1Gbit/s download speeds (such as the latest version of Virgin Media O2's cable network technology – DOCSIS 3.1).
[3] Note that we report on residential properties (homes) for full fibre, and superfast coverage, but report on both residential and commercial properties for 'decent' broadband.

Full fibre deployment: A third (33%) of homes have access to full fibre services. Full fibre coverage is now at just under 9.6 million, up from 8.2 million (28%) reported in our December 2021 report. This is driven predominantly through deployments by the larger fibre infrastructure operators but supported by a number of smaller providers across the UK serving individual communities and regions.

Superfast broadband (download speeds of at least 30 Mbit/s): Superfast broadband rollout across the UK continues to grow although at a reduced pace (coverage remains at 96% of UK homes). This may be due to the increasing difficulty in reaching the final 4% of properties, as well as the increased focus on rolling out new full fibre and other gigabit capable connections across the UK.

Decent broadband (at least 10 Mbit/s download and 1 Mbit/s upload speed): the vast majority of UK properties can access decent broadband. The number of properties (both residential and commercial) that cannot receive a decent broadband service from a fixed line stands at around 506,000 (remaining at 2%), having dropped from 650,000 since our December 2021 report.

Broadband services are also available from Fixed Wireless Access (FWA) networks, provided via mobile networks or through Wireless Internet Service Providers (WISPs). If managed well, FWA networks can deliver a decent broadband service, and can be used as an alternative network technology where consumers do not have access to a decent broadband connection on a fixed network. We continue to collect data from WISPs and based on the coverage reported by these providers, we now estimate that 7% of premises can receive a decent broadband service from a WISP (the same as in our December 2021 report). FWA coverage from mobile networks capable of providing decent broadband is available to almost 94% of premises.

Factoring in the coverage estimates provided by FWA providers, we estimate that there remain around 99,500 premises that do not have access to a decent broadband service from a fixed network or an FWA network. This has fallen from our estimate of 123,000 in our December 2021 report.

Of these, 78,600 premises are not expected to be covered by rollout by publicly funded schemes within the next twelve months. These may be eligible for the broadband USO product subject to further checks and confirmation by the Universal Service Providers (BT and KCOM).

The above figures show the availability of broadband services across the UK; we shall report on take-up of broadband services in more detail in our annual Connected Nations report in December 2022.

Key findings – Mobile

We measure mobile coverage in a way that reflects the likely experience of people using their mobile phones[4] There has not been a significant increase in coverage since our last report, but we expect the Shared Rural Network, agreed between the UK Government and industry in 2020, to drive forward coverage improvements over the coming years.

4G: Coverage of 4G mobile networks across the UK has not seen significant changes over the last reporting periods. Around 92% of the UK landmass is predicted to have good 4G coverage from at least one operator, and this area includes nearly all of the premises in the UK. This is expected to rise

[4] Detailed definitions are available in the December 2021 report methodology.

to 95% by end of 2025 as a result of the SRN. Coverage for both Scotland and Wales is currently significantly lower. It should be noted that individual MNOs are committed to achieving between 85% and 88% coverage in Wales by 2027[5] under the government's SRN investment, and between 82% and 85% in Scotland.

4G not-spots: The UK has both geographic and road not-spots (that is, areas where good 4G services are not available from any mobile operator). Geographic not-spots have remained the same as in our December 2021 report at 8%. Road coverage remains largely the same with just 4% of all roads estimated to be an in-vehicle not-spot. This varies significantly across individual nations, particularly in Scotland and Wales.

Calls and text coverage: As with 4G, predicted coverage remains largely unchanged over the previous reporting periods. 85-92% of the UK landmass is predicted to be covered, depending upon operator, for calls and text services and between 99-c.100% of premises (outdoors) in the UK, again depending upon operator.

Calls/text not-spots: Areas where people are unable to make a call or send a text from any operator (not-spots) is similarly unchanged, with around 4% of the UK geography estimated as a not spot, and with around 2% of the UK's roads estimated to be a not spot for calls and texts made or received in vehicle. As with 4G, there are marked variations for individual nations; for example, geographic not-spots across Scotland remain higher than the rest of the UK, at around 11%.

5G: We reported on 5G coverage from 'All MNOs' and from 'At least one MNO' for the first time in December 2021. We continue to report on the same basis here, with coverage levels ranging from high to very high confidence. Coverage from 'At least one MNO' now ranges from 47% (very high confidence) to 62% (high confidence) of premises outdoors, up from 42% and 57% respectively when we reported in December.

Schemes across the UK and Nations supporting broadband networks

Ofcom as part of its access review has set in place rules to drive investment which is now delivering results. These rules are set over a five-year period.

UK: On 22 February 2022, 'Gigabit Broadband in the UK: Government targets and policy'[6] was published. This re-confirmed the government commitment to reach 85% of UK households with Gigabit capable broadband by 2025 and that by 2030 this figure would reach at least 99%. The government targets for mobile include 95% geographic coverage for 4G and that the majority of population would have access to a 5G signal by 2030.

In February the Government published its response to the 'Improving Broadband for Very Hard to Reach Premises' consultation. In it they note that while the government is making significant progress in delivering improved connectivity to the country, they know that in some areas the cost of delivering gigabit-capable broadband coverage rises exponentially. Consideration of alternative

[5] This has been revised for 2026 since our last update.
[6] House of Commons Library, Gigabit Broadband in the UK: Government targets and policy, 25 February 2022.

options to connect some premises, initially estimated to be less than 100,000 in total, which are deemed 'Very Hard to Reach', is needed. The Government aims to set out policy proposals later in the year.

Scotland: The Scottish Government's Reaching 100% (R100) programme contract build is well underway with connections now live in all contract areas across Scotland, including the North Lot. Many homes and businesses due to receive superfast speeds through the R100 programme will now get even faster gigabit-capable broadband instead.[7] Additional support is provided through the Scottish Broadband Voucher Scheme.[8] In some cases, rural addresses may be eligible to combine Scottish Government funding of up to £5,000 with funding from the UK Government's Gigabit Broadband Voucher Scheme (GBVS) which provides £1,500 for rural homes and £3,500 for rural businesses.

The Scottish Government also continues to support network rollout through the Full Fibre Charter with communications providers. In April 2022, five more providers pledged support to maximise coverage in Scotland. In return, the Scottish Government offers 100% non-domestic rates relief on newly laid fibre until 2034.[9]

In addition, the Scottish Government's 4G Infill Programme continues with 27 live masts at the time of writing. Alongside the Shared Rural Network, this will help address 4G mobile not-spots across Scotland.[10]

Commercial rollout continues across Scotland. In December 2021, Virgin Media O2 announced that it had upgraded its entire Scottish network of 1.2 million homes to gigabit-capable broadband.[11] Openreach continues to expand its full fibre network in Scotland, announcing eight more Scottish locations as part of a £16.2 million investment.[12] There has also been further alt-net investment, including Lothian Broadband receiving £20m of funding from the Scottish National Investment Bank to help connect more than 70,000 new premises across Scotland over the next four years.[13]

Wales: More than 600 hospitals, police stations, libraries and other public buildings in Wales have been connected to full fibre broadband under the UK Government's drive to level up public services and speed up rollout. The Welsh Government has provided a progress update on their £52.5 million Phase 2 Superfast Cymru contract with BT, which confirms that 25,855 premises (up from 24,515 in Q3) have now gained access to fibre to the premises. The Welsh Government's Local Broadband Fund continues to support local authorities and social enterprises to deliver broadband projects locally. The Access Broadband Cymru[14] scheme also provides grants to fund (or part-fund) the installation costs of new broadband connections for homes and businesses in Wales.

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[7] Digital Scotland, Ensuring access to superfast broadband, 29 December 2021.
[8] Digital Scotland, Scottish Broadband Voucher Scheme.
[9] Scottish Government, Boosting broadband access, 2 April 2022.
[10] Scottish Government, Scottish 4G infill programme: progress update, 7 March 2022.
[11] Virgin Media O2, Virgin Media O2 connects entire network in Scotland to next-generation gigabit broadband, 1 December 2021.
[12] Openreach, New £16m broadband boost for Scotland, 25 January 2022.
[13] The Scottish National Investment Bank, Lothian Broadband Group, 6 January 2022.
[14] Welsh Government, Access Broadband Cymru grant scheme, 31 March 2022.

Northern Ireland: A further 8,500 premises have been added to the Project Stratum broadband intervention scheme in Northern Ireland. The additional premises include 2,500 harder-to-reach properties that were out of scope of the original contract, plus a further 6,000 premises.

The £165 million contract for delivery of Project Stratum was awarded to Fibrus Networks Ltd in November 2020. By the end of 2021, Fibrus had delivered new infrastructure to more than 22,000 premises.

The roll-out of the new full fibre network to reach all 85,000 premises, including the additional 8,500 premises being brought into the scope of project Stratum, will continue across four extended quarters of network build, with Fibrus Networks expected to complete full deployment by March 2025.

Data collection and reporting

We continue to increase the number of operators from whom we collect coverage data to improve the accuracy of the data we publish. We also continue to gather coverage data every four months and usage information once a year.

We are in the process of collecting and analysing planned network build information from communications providers in the UK and we shall be publishing the results of this activity in due course.

2. Dashboards

Fixed broadband

Access to full fibre	May 2021	September 2021	January 2022
UK	24%	28%	33%
England	23%	27%	31%
Northern Ireland	67%	71%	79%
Scotland	23%	27%	32%
Wales	24%	27%	32%

Access to Gigabit-capable services	May 2021	September 2021	January 2022
UK	40%	47%	66%
England	38%	46%	67%
Northern Ireland	73%	76%	82%
Scotland	47%	51%	60%
Wales	30%	36%	46%

Access to superfast services	May 2021	September 2021	January 2022
UK	96%	96%	96%
England	96%	96%	97%
Northern Ireland	90%	91%	92%
Scotland	94%	94%	94%
Wales	94%	94%	95%

Access to at least 10 Mbit/s services	May 2021	September 2021	January 2022
UK	98%	98%	99%
England	99%	99%	99%
Northern Ireland	95%	95%	96%
Scotland	97%	97%	97%
Wales	97%	97%	98%

Fixed Wireless Access

Since our last report we have continued to collect data for Wireless Internet Service Providers (WISPs) providing a Fixed Wireless Access broadband service. The following shows premises where decent broadband is obtainable via FWA.

Fixed Wireless	May 2021	September 2021	January 2022
UK Mobile Network Operators (MNO)	93%	94%	94%
UK Wireless Internet Service Providers (WISP)	6%	7%	7%

USO eligibility

The percentage of homes and businesses unable to access a decent broadband service, that is at least 10 Mbit/s download speed and at least 1 Mbit/s upload speed.

Unable to receive 10 Mbit/s download and 1 Mbit/s upload services (potentially USO eligible	May 2021	September 2021	January 2022
UK	0.4%	0.4%	0.3%
England	0.3%	0.2%	0.2%
Northern Ireland	2%	2%	2%
Scotland	1%	1%	1%
Wales	1%	1%	0.8%

Note 1: We consider a property to have "full fibre coverage" only if: 1. fibre is deployed in close proximity to the premises, so only a dedicated fibre connection to the property is necessary to provide full (end to end) fibre connectivity, and 2.the end user would expect to pay only a published pre-agreed connection charge, if one was to be imposed.

Note 2: This may exclude broadband services available from some smaller providers.

Note 3: Figures for potential USO eligibility are for all (both residential and commercial) properties. Figures for other speeds refer to residential properties only.

5G coverage

Premises (outdoor) covered by at least one operator	January 2022
UK	47-62%
England	49-65%
Northern Ireland	24-34%
Scotland	40-54%
Wales	27-38%

Premises (outdoor) covered by all operators	January 2022
UK	4-12%
England	5-13%
Northern Ireland	2-6%
Scotland	2-8%
Wales	2-5%

Note 4: Thresholds for 5G Service are -110 dBm where we have high confidence in coverage and –100 dBm where we have very high confidence in coverage.

4G coverage

Premises (outdoor) – coverage range across MNOs	May 2021	September 2021	January 2022
UK	99%	99-c.100%	98-c.100%
England	99-c.100%	99-c.100%	99-c.100%
Northern Ireland	96-99%	97-99%	97-99%
Scotland	97-99%	97-99%	97-99%
Wales	96-99%	96-99%	95-99%

Geographic area – coverage range across MNOs	May 2021	September 2021	January 2022
UK	79-85%	79-86%	79-86%
England	92-93%	92-94%	92-94%
Northern Ireland	86-92%	87-92%	87-92%
Scotland	57-72%	57-73%	57-74%
Wales	72-83%	72-84%	72-85%

Geographic area not covered by any operator (not spots)	May 2021	September 2021	January 2022
UK	8%	8%	8%
England	3%	2%	2%
Northern Ireland	3%	3%	3%
Scotland	19%	18%	18%
Wales	10%	10%	10%

Coverage of all roads (in vehicle) – coverage range across MNOs	May 2021	September 2021	January 2022
UK	78-83%	78-83%	78-83%
England	83-88%	83-88%	83-88%
Northern Ireland	62-79%	63-79%	65-79%
Scotland	64-75%	64-77%	64-78%
Wales	70-78%	70-79%	70-79%

All roads (in vehicle) not covered by any operator (not spots)	May 2021	September 2021	January 2022 (Note 6)
UK	4%	4%	4%
England	2%	2%	2%
Northern Ireland	7%	6%	7%
Scotland	8%	7%	7%
Wales	10%	9%	9%

Note 5: Thresholds for 4G services: 4G (-105 dBm). This relates to nearly all connections being capable of delivering a connection speed of at least 2Mbit/s and reliable voice calls.

Note 6: For Northern Ireland the difference between September 2021 and January 2022 is just over 0.1%, but due to rounding is reported higher. These circumstances, with reported coverage varying +/- 1% can arise from time to time as a result of small changes in the underlying information we use to calculate coverage. All reported coverage is based on predictions, which the operators continue to update. The Connected Nations 2021 methodology provides more details on how mobile coverage is calculated.

Voice and text coverage

Premises (outdoor) – coverage range across MNOs	May 2021	September 2021	January 2022
UK	99-c.100%	99-c.100%	99-c.100%
England	c.100%	c.100%	c.100%
Northern Ireland	98-c.100%	98-c.100%	98-c.100%
Scotland	99-c.100%	99-c.100%	99-c.100%
Wales	99%	99%	99%

Geographic area – coverage range across MNOs	May 2021	September 2021	January 2022
UK	85-92%	85-92%	85-92%
England	94-98%	95-98%	95-98%
Northern Ireland	89-98%	89-98%	89-98%
Scotland	68-81%	68-82%	68-82%
Wales	85-91%	86-91%	86-91%

Geographic area not covered by any operator (not-spots)	May 2021	September 2021	January 2022
UK	5%	4%	4%
England	1%	1%	1%
Northern Ireland	1%	1%	1%
Scotland	11%	11%	11%
Wales	5%	5%	5%

Coverage of all roads (in vehicle) – coverage range across MNOs	May 2021	September 2021	January 2022
UK	86-94%	86-94%	86-95%
England	90-98%	90-98%	90-98%
Northern Ireland	70-93%	71-93%	72-93%
Scotland	77-88%	77-88%	77-88%
Wales	82-88%	82-88%	82-88%

All roads (in vehicle) not covered by any operator (not-spots)	May 2021	September 2021	January 2022
UK	2%	2%	2%
England	1%	1%	1%
Northern Ireland	3%	3%	3%
Scotland	4%	4%	3%
Wales	5%	5%	5%

Note 7: Thresholds for voice and text are: 2G (-81 dBm), 3G (-100 dBm), 4G (-105 dBm).

The Planning Inspectorate

Appeal Decision

Site visit made on 1 November 2018

by Andrew Dawe BSc(Hons) MSc MPhil MRTPI

an Inspector appointed by the Secretary of State

Decision date: 23 November 2018

Appeal Ref: APP/Q3305/W/18/3206555
Footpath adjacent to Whiting Way, Wells, Somerset BA5 2QF

- The appeal is made under section 78 of the Town and Country Planning Act 1990 against a refusal to grant approval required under a development order.
- The appeal is made by Vodafone Ltd against the decision of Mendip District Council.
- The application Ref 2017/3382/TEL, dated 6 December 2017, was refused by notice dated 8 February 2018.
- The development proposed is 15m electronic communications mast and associated equipment.

Decision

1. The appeal is allowed and approval is granted under the provisions of Schedule 2, Part 16, Class A of the Town and Country Planning (General Permitted Development) (England) Order 2015 (the GPDO) for 15m electronic communications mast and associated equipment at Footpath adjacent to Whiting Way, Wells, Somerset BA5 2QF in accordance with the terms of the application, Ref 2017/3382/TEL, dated 6 December 2017, and the plans submitted with it.

Procedural Matters

2. Notwithstanding the description of development in the fourth bullet point of the above header, I note from the original application form that the proposed mast would comprise a replica telegraph pole with internal antenna in a brown timber replica finish, and that the proposal would also include associated dark green steel radio equipment cabinets. I have determined the appeal on that basis.

3. Since the submission of the appeal, the new revised National Planning Policy Framework (July 2018) (the Framework) has been published which replaces the first version published in 2012. The Council and appellant have had the opportunity to comment on this during the appeal process. I have determined the appeal taking account of the new revised version.

Main Issues

4. The main issues are:

   i) whether or not there is a need for the proposed mast, as opposed to making use of any existing mast, building or other structure, in order to provide an efficient operation of the network;

ii) whether the proposal would preserve or enhance the character or appearance of the nearby Wells Conservation Area (the CA) and preserve the setting of listed buildings (LBs) in the vicinity, and in the event that any harm is identified, whether that harm would be outweighed by any public benefits.

Reasons

GPDO basis for determining the appeal

5. The GPDO sets out in Schedule 2, Part 16, Class A that development by or on behalf of an electronic communications code operator for the purpose of the operator's electronic communications network in, on, over or under land controlled by that operator or in accordance with the electronic communications code, consisting of, amongst other things, the installation, alteration or replacement of any electronic communications apparatus, or development ancillary to radio equipment housing, is permitted development subject to certain criteria set out in paragraph A.1 and conditions set out in paragraphs A.2 and A.3. The Council has not raised any issues in respect of paragraph A.1 and I have no reason to conclude differently.

6. However, paragraph A.3(4) states that before beginning the development, the developer must apply to the local planning authority for a determination as to whether the prior approval of the authority will be required as to the siting and appearance of the development. My determination of this appeal relates to the Council's refusal of such approval.

Need

7. Having regard to paragraphs 113 and 115 of the Framework, it is evident from the submissions that the appellant has investigated the possibility of utilising existing buildings, masts or other structures but that no suitable options are available. I note that other locations for the proposed development have been suggested by local residents. However there is no substantive evidence to clearly demonstrate that they are available, would meet the operational requirements, and be less visually prominent than the appeal proposals.

8. I have also taken into consideration that the Council no longer raises objection to the proposed mast in light of the appellant's evidence relating to coverage requirements and other sites not being available or suitable. Based on that evidence, and whilst taking account of the rebuttal submissions of local residents in this respect, I have insufficient substantive basis to consider differently to the Council. Furthermore, whilst I have determined the appeal on its merits based on all of the submitted evidence, I have had regard to the circumstance whereby the Council has granted prior approval for an albeit lower, 12.5 metre high, mast on the same site since its decision relating to the appeal proposal. In terms of the matters concerning this main issue, that is therefore a significant material consideration to which I have afforded substantial weight due to the fallback position it establishes for a new mast at this site.

9. For the above reasons, I conclude on this issue that there is a need for the proposed mast, as opposed to making use of any existing mast, building or other structure, in order to provide an efficient operation of the network. The proposed siting would therefore be acceptable in this respect.

Character or appearance of the CA and setting of the LBs

10. The site is located close to the CA and at varying distances from the LBs. Special attention has to be paid to the desirability of preserving or enhancing the character or appearance of the CA and preserving the setting of the LBs. The CA comprises a variety of designs and types of buildings and includes the LBs which contribute to its pleasant historic character. The LB of particular relevance is the Grade I listed Church of St. Cuthbert, the tower of which is particularly prominent as seen from the appeal site and its vicinity. Other nearby LBs comprise the Grade II* listed Budwiths Almhouses close to the southern end of Whiting Way, and those along Priests Row to the south-east of Whiting Way.

11. The proposed mast would be positioned within a line of existing lampposts relating to both Whiting Way and the adjacent supermarket car park. It would be thicker than those existing features but nevertheless of a uniform appearance and a still fairly slender design. In these respects, notwithstanding its significantly greater height, it would not appear out of place in terms of only representing one additional vertical feature into the immediate streetscene. Furthermore, the increased height would not be an isolated or dominating feature seen from the closer approaches on that side of the road due to the positioning of the existing lampposts in the foreground. In that respect, it would therefore also not be generally seen in isolation against the backdrop of the tower of the listed church.

12. Nevertheless, it would be seen in varying degrees of isolation against the backdrop of the sky from other local vantage points and in that respect would stand out as being a taller feature than others in the vicinity. In this respect, it would be seen to some extent in the same context as the church tower against the sky backdrop. However, its fairly slender and uniform design would lessen its prominence and massing effect. Furthermore, in looking from the CA, including the southern end of Whiting Way and Portway Avenue, it would be seen to varying extents in the context of those existing lampposts on Whiting Way, telegraph poles in Portway Avenue and the modern building comprising the supermarket adjacent to the site, albeit that it would be taller than those features. The degree of separation from the Budwiths Almhouses and those LBs along Priests Row, together with the presence of intervening buildings and vegetation, which would also restrict the degree of inter-visibility between those assets and the proposal, would ensure that their particular settings would be unlikely to be materially harmed.

13. Additionally, the proposed equipment cabinets would be of fairly modest size and not dominant features in the context of the other nearby street furniture, including the lampposts, and positioning on a wider section of footway. I have had regard to concerns raised about the proposal being a target for graffiti and vandalism. However, I have no substantive evidence to indicate the likelihood of such, and in any case any anti-social behaviour would have the potential to be controlled by other means outside of the planning system.

14. For these reasons the extent to which the proposal would harm the character and appearance of the nearby CA and the settings of the LBs in the vicinity would be low. With regard to paragraphs 193, 194 and 196 of the Framework, harm to the significance of those designated heritage assets would be less than substantial due to the relatively small scale of development involved. In

considering the need for the proposal, Government policy, as set out in the Framework states that advanced, high quality and reliable communications infrastructure is essential for economic growth and social well-being. In this respect, I have found that there is a need for the proposal which therefore weighs strongly in its favour. As I have found that the level of harm relating to this second main issue would be low, that identified need would outweigh the harm in this case.

15. For the above reasons, I conclude on this issue that despite the less than substantial harm that would be caused, the public benefits of the proposal would outweigh that harm. As such it would accord with Development Policy 3 of the Mendip District Local Plan which relates to heritage conservation and sets out that any harm to a heritage asset requires justification and the demonstration of overriding public benefits which would outweigh the damage to that asset or its setting. It would also accord with paragraphs 193, 194 and 196 of the Framework in this respect.

Other matters

16. Concerns have been raised by local residents about potential effects on health due to the proximity of residential properties, schools and outdoor recreation facilities. However, the appellant has provided a declaration to certify that the proposal has been designed to conform with the guidelines published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). In these circumstances, the Framework advises that health safeguards are not something which a decision-maker should determine. No sufficiently authoritative evidence has been provided to indicate that the ICNIRP guidelines would not be complied with or that a departure from national policy would be justified.

17. Concern has also been raised about highway safety in terms of obstruction to the visibility of drivers exiting the Waitrose car park and also due to the mast being a distraction to drivers. However, there is no substantive evidence provided to justify the concerns, and I have no basis to consider that the proposal would pose a risk to highway safety. Furthermore, in respect of the former concern, the development would be set away from the edge of the highway and thereby likely to ensure the retention of existing levels of visibility. As such it would also not impede visibility of drivers on the road. The footway in that location is also fairly wide such that the proposal would be unlikely to cause an obstruction to pedestrians and people using mobility scooters or to force them into the road. Furthermore, the Council's Highways section raises no objections and for the above reasons I have no substantive basis to consider otherwise.

18. I have had regard to concerns about the effect of the proposal on tourism within Wells, having regard to its visual impact. However, in light of the low level of harm that I have found would be caused in respect of the second main issue, I consider that it would be unlikely to have a materially detrimental effect in respect of this matter.

19. In respect of concern raised about the effects of the proposal on bees, I have received insufficient substantive evidence to demonstrate that any significant harm would be caused in this respect.

20. Concern has been raised about a precedent being set for other masts being erected in the city. However, any future proposals would have to be considered on their own merits as I have done in this case.

Conditions

21. Standard conditions are set out in the GPDO for development by electronic communications code operators and it is not necessary for me to impose any additional conditions beyond those.

Conclusion

22. For the above reasons, I conclude that the appeal should be allowed.

Andrew Dawe

INSPECTOR

The Planning Inspectorate

Appeal Decision

Site visit made on 29 August 2018

by Rory MacLeod BA MRTPI

an Inspector appointed by the Secretary of State

Decision date: 17 October 2018

Appeal Ref: APP/L1765/W/18/3197522
Land at junction of Andover Road and Athelsan Road, Winchester SO23 7RY

- The appeal is made under section 78 of the Town and Country Planning Act 1990 against a refusal to grant approval required under Schedule 2, Part 16 , Class A of the Town and Country Planning (General Permitted Development) (England) Order 2015 (as amended).
- The appeal is made by CTIL & Vodafone Ltd against the decision of Winchester City Council.
- The application Ref 17/01930/TCP, dated 21 July 2017, was refused by notice dated 13 September 2017.
- The development proposed is installation of a 17.5m pole, supporting 3 no antenna, associated ground based equipment cabinets and ancillary development thereto.

Decision

1. The appeal is allowed and approval is granted under the provisions of Schedule 2, Part 16 , Class A of the Town and Country Planning (General Permitted Development) (England) Order 2015 (as amended) for the siting and appearance of a 17.5m pole, supporting 3 no antenna, associated ground based equipment cabinets and ancillary development at land at the junction of Andover Road and Athelsan Road, Winchester SO23 7RY in accordance with the terms of the application Ref 17/01930/TCP, dated 21 July 2017 and the plans submitted with it.

Main Issues

2. The main issues are the effect of the proposal on the character and appearance of the area and, in the event that any harm is identified, whether that harm would be outweighed by the need to site the installation in the location proposed having regard to the potential availability of alternative sites.

Reasons

Character and appearance

3. Within certain limits, the General Permitted Development Order (GPDO) grants permission for the development of telecommunications equipment subject to a prior approval procedure. Planning Practice Guidance explains that this is a "*light-touch*" process compared to an application for planning permission. There is no dispute between the parties that the proposal falls within the remit of Schedule 2, Part 16, Class A. Therefore, in accordance with the provisions of Class A.3 (3), there is a requirement to assess the impact of the proposal's siting and appearance on the local area.

4. The site is located on Andover Road, a busy road with rising land levels to the north of the site and with falling land levels to the south towards Winchester. The surrounding area is of mixed character including an open car park and residential areas to the east and a retail park and railway line to the west. The proposal would be sited within a section of the footway where the kerb has been built out alongside a pedestrian crossing on Andover Road. The pole would be located within the kerb build out whilst the two cabinets would be sited on the back edge of the footway.

5. There are several vertical structures along this part of the road including street lamps, telegraph poles, street signs and traffic lights, but at 17.5m, the pole would be considerably higher than any of these. Its additional width compared with other structures would also result in the pole appearing as a conspicuous feature. Whilst from some viewpoints a backdrop of trees would soften the appearance of the pole, from other locations along Andover Road, it would appear as a prominent feature. Its siting on the kerb build out close to the road carriageway would add to this prominence when viewed from positions closer to the site. Although such poles and associated cabinets are becoming more commonplace, the height of the proposed pole and its prominent siting would not assist its assimilation into the street scene when viewed from close quarters. There would therefore be some harm to the character and appearance of the area.

6. The Council's appeal statement refers to Policy WIN3 of the Winchester Local Plan Part 2 (2017) (LPP2), a policy not included in the decision notice, relating to important views including of Winchester Cathedral and St Catherine's Hill. Whilst the pole would be seen against the skyline, there is not an uninterrupted view of these features from the approach to the appeal site. Given the separating distances and that buildings, trees and other similar vertical structures also filter views towards these features, the proposal would not have a significant effect on any important views that Policy WIN3 seeks to protect.

7. There would be a pinch point of about 1.2m in the width of the footway between one of the cabinets and the southern edge to the kerb build out. To the south of this the footway would have a width in excess of 2m whilst to the north, where the kerb is built out, the width would be about 4m. The site is by a pedestrian crossing and near to a school and play ground, so there may be occasions when there are many pedestrians and some with prams or push chairs passing the site. But even allowing for such heavy pedestrian flows, the limited extent of the narrowing of the footway would not result in a significant obstruction, particularly given the much wider footways that would remain to either side of the proposal.

8. The appellant has drawn to my attentions several allowed appeal decisions in which there has been an assessment of the effect of a telecommunications pole on the character and appearance of the area. The height of the pole proposed and the characteristics of the areas surrounding these development sites vary from site to site. The circumstances of each proposal have to inform the assessment of the individual merits of each case. Whilst mindful of these decisions, my findings are that the siting and appearance of the pole proposed in this appeal would nonetheless result in some harm to the character and appearance of the area due to its contrast in scale in relation to other linear features nearby and the pole's prominent siting.

Benefits and planning balance

9. The Government places a high priority on the provision of high quality communications. The National Planning Policy Framework (the Framework) at Paragraph 112 states, "*Advanced, high quality and reliable communications infrastructure is essential for economic growth and social well-being. Planning policies and decisions should support the expansion of electronic communications networks, including next generation mobile technology (such as 5G) and full fibre broadband connections*". In this instance, the proposal is not so much seeking to provide significantly higher standards but to maintain recent local provision of 2G, 3G and 4G services as a result of a notice to quit from a nearby site that was providing these services. The Council has commented that service provision would be 'adequate' without the proposal, but the appellant has an obligation to provide not only appropriate coverage but also capacity for the network. I attach significant weight to the public benefit arising from the continuation of local service provision.

10. It is then relevant to consider available evidence as to whether these benefits could be achieved by siting a telecommunications pole and cabinets elsewhere with lesser harm to the character and appearance of the area, and without significant harm arising in other respects. The appellant has installed a temporary mast farther north along Andover Road on the corner with Bereweeke Road. This is currently maintaining service provision, but the appellant has commented that this site would provide insufficient coverage and capacity for a permanent installation.

11. I note that following the withdrawal of an earlier application for an installation at the appeal site, there followed a site meeting and dialogue between the Council and the appellant on alternative sites for the required facility. The Council suggested a rooftop installation at Elizabeth Court, but the building turned out not to be available. The appellant has submitted a list of alternative sites investigated including on railway land, on street and at green field sites, but all have been discounted. The Council has not challenged these findings or suggested any additional sites to investigate. There has been opportunity for dialogue on this issue and I have no evidence to suggest that there is a more viable option than the appeal site for the required facility.

12. The question then arises could a development with a lesser impact reasonably be provided on the site other than that proposed? The appellant has demonstrated that the pole's height would be necessary to clear obstructions to signal from trees and buildings. Its width would be the minimum necessary to support the antennae at the top of the pole. The cylindrical shroud to contain the antennae would be the widest part of the structure, but would nonetheless have a compact form, sufficient to meet operational requirements. Furthermore, it would also have the benefit of supporting the networks of two mobile phone companies. Such mast sharing is consistent with the Government's aim to keep the number of sites for such installations to a minimum consistent with the needs of consumers.

13. Having regard to all relevant considerations, including national planning policy and the potential availability of alternative sites, my findings are that the proposal's public benefit in maintaining and enhancing local telecommunication coverage and capacity would outweigh the limited harm arising to the character and appearance of the area.

14. Policy DM22 of the LPP2 is the only local planning policy expressly dealing with telecommunication matters. As the proposal would facilitate site sharing, and minimise the local impact of the pole and associated cabinets, there would not be any substantive conflict with this policy. The proposal would also be compatible with Policy CS13 of the Winchester District Local Plan Part 1 relating to high quality design and with Policies DM15 and DM16 of the LPP2 in relation to local distinctiveness and site design criteria.

Other Matters

15. There have been several representations against the proposal from local residents, mainly raising issues that I have addressed above. Some have expressed concerns about the impact on visual amenity for the nearest residential buildings in Athelstan Road. Having regard to the separation distances, the orientation of these buildings and the presence of intervening trees, there would not be a materially detrimental impact on living conditions or on outlook at these dwellings.

16. Concerns have been raised about the potential effect on health arising from the monopole's proximity to residential properties and to schools and a play area. The appellant has provided a certificate to confirm that the proposal has been designed to comply with the guidelines published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). In these circumstances the Framework advises that health safeguards are not something for a decision maker to determine.

Conclusion

17. Whilst I acknowledge that there would be limited harm to character and appearance of the area from the siting of the pole, this would be outweighed by the public benefits arising from the proposal. For the reasons given, and having regard to all other matters raised, the appeal is allowed subject to the standard conditions set out in Paragraph A.2 to Part 16 of the GPDO.

Rory MacLeod

INSPECTOR

The Planning Inspectorate

Appeal Decision

Site visit made on 31 May 2016

by Clive Tokley MRTPI

an Inspector appointed by the Secretary of State for Communities and Local Government

Decision date: 14 June 2016

Appeal Ref: APP/R5510/W/16/3143922
Land at junction of Harmondsworth Road and Sipson Road, West Drayton, UB7 9JJ.

- The appeal is made under section 78 of the Town and Country Planning Act 1990 against a refusal to grant planning permission.
- The appeal is made by CTIL and Telefonica UK Ltd against the decision of the Council of the London Borough of Hillingdon.
- The application Ref 56867/APP/2015/2910, dated 31 July 2015, was refused by notice dated 23 September 2015.
- The development proposed is installation of a 15m high street works pole supporting 6no antennas, 2no ground based cabinets and development ancillary thereto.

Decision

1. The appeal is allowed and planning permission is granted for the installation of a 15m high street works pole supporting 6no antennas, 2no ground based cabinets and development ancillary thereto at Land at junction of Harmondsworth Road and Sipson Road, West Drayton, UB7 9JJ. The permission is in accordance with the terms of the application, Ref 56867/APP/2015/2910 dated 31 July 2015 subject to the following conditions:

   1) The development hereby permitted shall begin not later than three years from the date of this decision.

   2) The development hereby permitted shall be carried out in accordance with the following approved drawings: 100 Issue C, 200 Issue E and 300 Issue E.

   3) When no longer needed for reception or transmission purposes the street works pole and cabinets shall be removed from the land as soon as reasonably practicable. The land shall then be restored to its condition before the development took place (grass verge).

Main Issue

2. The main issues are:-

   - Whether the proposal would preserve or enhance the character or appearance of the West Drayton Green Conservation Area (CA).

   - Whether any harm caused to the CA would be outweighed by the need to site the installation in the location proposed having regard to the potential availability of alternative sites.

Reasons

3. At its northern end the CA comprises mainly C19 and C20 housing with areas of open space to the south. Harmondsworth Road skirts the eastern edge of the CA and for most of its length the west side of the road is open land in various uses including a cemetery, allotment gardens and partly-wooded parkland. The east side of Harmondsworth Road has a more built up character including, at the junction with Sipson Road, a parade of shops with two floors of residential accommodation above. The buildings fronting east side of Harmondsworth Road are outside the CA whereas the grass verge between the service road and the main road, including the appeal site, is within the CA.

4. The largely undeveloped west side of Harmondsworth Road is fronted by mature trees and hedges and contrasts with the east side of the road with its shopping parade, road junction and narrow grass verges. The area around the junction is populated with street lights, CCTV camera poles, traffic lights, road signs, railings and utilities cabinets of various sizes and colours. Within this area is one street works pole similar to that now proposed. To both the north and south of the junction the density of road side paraphernalia decreases.

5. When viewed from the north, from within the CA, the tops of the taller structures (lamp posts and street works pole) are seen above the roof level of the shopping parade however the lower level structures merge into the background. When approaching from the south the structures are more clearly distinguishable against the more open background of the junction and the trees and local shop beyond. However the existing street works pole appears to fall into the line of the street lights. Whilst being taller and bulkier than the street lights I consider that it is not unduly intrusive. When approaching the CA along Sipson Road the street pole and utilities boxes are not apparent until close to the junction and the density of structures appears to be less than from the other viewpoints.

6. The appellant indicates that the proposal is needed to provide new 4G coverage and enhance 2G and 3G capacity in the area. The Council does not challenge the need for the proposal and the Officer report indicates that the Council is satisfied that the appellant has demonstrated that no preferable alternative locations are available or acceptable (including the existing nearby installation). It appears to me that there are very limited opportunities for development of the type proposed within the search area. The National Planning Policy Framework (the Framework) indicates that when determining applications for telecommunications development the need for the installation should not be questioned. I have no reason to disagree with the appellant's indication that the installation is necessary and that no satisfactory alternatives are available.

7. The proposed pole would be 20m from the existing pole and the southernmost proposed cabinet would be about 14m from the nearest existing cabinet. In the context the existing tall structures at the junction I consider that when viewed from Harmondsworth Road in both directions the proposed street pole would not unduly detract from the character or appearance of the area. The pole would be more prominent from Sipson Road where it would be seen against the background of the trees to the west. Cabinets of the type proposed are commonplace within urban streets and being separated from the existing cabinets they would not result in an unacceptable concentration of such

structures. I consider that the proposal would not seriously harm the townscape of the area and therefore it would not conflict with the Council's specific policy for the consideration of telecommunications developments (Policy BE37 of the London Borough of Hillingdon UDP Saved Policies September 2007).

8. I consider that the additional structures would result in limited harm to the character and appearance of the CA in the immediate vicinity of the appeal site and would detract from views into the CA from Sipson Road. However the area around the proposal is not typical of the character of the CA and I consider that in this context the harm caused to the significance of the CA would be "less than substantial" as defined by the Framework.

9. The Framework sets out the importance of an advanced high quality communications infrastructure for sustainable growth and makes specific reference to the development of high speed broadband technology. This is reflected in the London Plan and the public benefit arising from the improvement of the telecommunications infrastructure is a material planning consideration that weighs in favour of the proposal.

10. Taking account of all matters I have concluded that the limited harm caused to the significance of the heritage asset (the CA) would be outweighed by the public benefit that would arise from improving the communications infrastructure.

Conditions

11. I have imposed the standard conditions limiting the time within which the development must be commenced and identifying the approved drawings. As the need for the proposal is the principal justification for the granting of permission I agree with the Council that a condition should be imposed requiring the removal of the development if it is no longer needed for telecommunications purposes.

Conclusion

12. I have concluded that the proposal would result in limited harm to the character and appearance of the CA; however that harm would be outweighed by the public benefit that would arise from improving the communications infrastructure and that the appeal should succeed.

Clive Tokley

INSPECTOR

The Planning Inspectorate

Appeal Decision

Site visit made on 12 October 2020

by Andrew Bremford BSc (Hons) MRICS

an Inspector appointed by the Secretary of State

Decision date: 29 October 2020

Appeal Ref: APP/K3605/W/19/3243927
Bridge Road (southwest of junction with Arnison Road), East Molesey KT8 9HY

- The appeal is made under section 78 of the Town and Country Planning Act 1990 against a refusal to grant approval required under Schedule 2, Part 16, Class A of The Town and Country Planning (General Permitted Development) (England) Order 2015 (as amended).
- The appeal is made by MBNL (EE Ltd and H3G UK Ltd) against the decision of Elmbridge Borough Council.
- The application Ref 2019/1219, dated 30 April 2019, was refused by notice dated 25 June 2019.
- The development proposed is installation of a 15m high monopole incorporating shrouded antenna and supporting 2no. external dishes and development ancillary thereto.

Decision

1. The appeal is allowed and approval is granted under the provisions of Article 3(1) and Schedule 2, Part 16, Class A of the Town and Country Planning (General Permitted Development) (England) Order 2015 (as amended) for the siting and appearance of a 15m high monopole incorporating shrouded antenna and supporting 2no. external dishes and development ancillary thereto at Bridge Road (southwest of junction with Arnison Road), East Molesey KT8 9HY, in accordance with the application ref: 2019/1219, dated 30 April 2019, and the plans submitted with it.

Procedural Matters

2. The appellant contends that the Council failed, in accordance with the procedures set out in Schedule 2, Part 16, Class A of the Town & Country Planning (General Permitted Development) (England) Order 2015 (as amended) (hereafter the GPDO 2015), to give the appellant or their agent written notice of its determination that prior approval was required. The appellant contends that in these circumstances the Council's refusal notice is not valid. However, the evidence is clear that the Council issued a letter to the agent on 9 May 2019 clarifying that the prior approval of the local planning authority is required for the siting and appearance of the development proposed by application ref: 2019/1219, dated 30 April 2019.

3. The Council's refusal notice refers to the effect of the proposed 15m high monopole on the character and appearance of the area. It also refers to the effect of 'associated equipment cabinets'. However, the application was solely

for development as described in the banner heading above. I have therefore determined the appeal on this basis.

4. The provisions of the GPDO 2015, under Article 3(1) and Schedule 2, Part 16, Class A, Paragraph A.3(4) require the local planning authority to assess the proposed development solely on the basis of its siting and appearance, taking into account any representations received. My determination of this appeal has been made on the same basis.

Planning Policy

5. The principle of development is established by the GPDO 2015 and the provisions of Schedule 2, Part 16, Class A of the GPDO 2015 do not require regard be had to the development plan. I have had regard to the policies of the development plan and the National Planning Policy Framework (the Framework) only in so far as they are a material consideration relevant to matters of siting and appearance.

Main Issue

6. The main issue is the effect of the siting and appearance of the proposed development upon the character and appearance of the area.

Reasons

7. The proposed 15m high mast would be a slim monopole design and coloured 'fir green'. It would host three shrouded antennas and two external dishes and would be located at the back edge of the grass verge adjacent to a low wall which separates the grounds of Boleyn Court from the verge and public footway on the western side of Bridge Road. The site is close to the junction of Bridge Road and Arnison Road where there is existing street furniture including two telecommunications cabinets, a bench and a waste bin.

8. Boleyn Court is a residential block of flats located at the junction of Bridge Road and Arnison Road. Owing to the orientation of the building within the corner plot its front elevation faces the road junction and the site. However, there is a grassed area in front of the building which forms part of its gardens. Moreover, mature deciduous and evergreen trees, interspersed with other vegetation, line the inside boundary of the gardens along Bridge Road and Arnison Road.

9. The site is approached from gentle curves in both directions along Bridge Road, which is characterised by a mix of generally low level residential and commercial development. However, there are large mature trees along the eastern side of Bridge Road opposite the junction with Arnison Road and others just within the boundary of the listed Kingfisher Court. The site lies just outside the East Molesey (Kent Town) Conservation Area and the East Molesey (Bridge Road) Conservation Area. There are also other listed buildings nearby.

10. I visited when leaf fall had only just begun, however the evidence in the form of photomontages shows how the proposed mast would appear in some views against a backdrop of largely denuded tree branches. In views along Arnison Road and from the north east along Bridge Road the mast would mainly appear through or against the tall and spreading cover of the trees and so its impact would be limited. Although the mast would extend above the line of trees in views from the south west along Bridge Road a significant portion of

its midsection length would be obscured by tree and vegetation cover including evergreen trees.

11. The mast would be taller and thicker than the existing nearby street lighting columns, road signs and overhead cable poles. Due to its height, the mast would be visible in local views from the public domain and from some residential properties in proximity to the site including the flats within Boleyn Court. However, such masts are becoming more commonplace within the urban environment and so it would not appear as an alien or unexpected feature. Although the mast would rise to a greater height than the line of trees within the grounds of Boleyn Court and nearby buildings, the excess height is limited. The structure would not therefore appear unduly tall within this context. As a result of its slimline design and green colour the mast would not visually compete with the trees. Because of their maturity and substantial size, in all respects except for maximum height the trees would remain considerably more prominent in longer views than the proposed mast.

12. Taking into account the location of the boundaries of the two Conservation Areas relative to the site, in longer range views, the gentle curves of Bridge Road and the intervening trees would substantially reduce the visual impact of the development in views in and out of the two Conservation Areas. Consequently, the proposal would have a minimal effect on their settings and so there would be no harm to the character, appearance or significance of the Conservation Areas.

13. The closest listed buildings are at Kingfisher Court to the east and Nos 95 and 97 Bridge Road to the south west. Views from around the site of these locations, in which the proposed mast would also be visible, are relatively limited and largely obscured by trees. As such, the proposal would preserve the particular significance of these heritage assets and their settings.

14. The proposed mast would be visible in the street-scene. However, for the reasons outlined above, it would not result in any significant harm to the character and appearance of the area.

Other Issues Raised

15. Interested parties have raised a number of other issues. Taking into account the slim profile of the proposal and the intervening distances involved, the proposal would not be unacceptably overbearing or intrusive when viewed from residential properties in the vicinity of the site including from the flats within Boleyn Court. Consequently, there would be no adverse effect on the living conditions of nearby residents through loss of outlook. The proposal does not create overlooking, so it does not raise privacy issues. Construction works and maintenance activities would likely lead to some disruption, but these activities would be temporary and any effects from them would be short-term. Concerns have also been raised that the proposal would devalue house prices in the neighbourhood. However, it is well established[1] that the planning system does not exist to protect private interests such as the value of property.

16. Concerns have been raised about the potential effects on health and, in this regard, the proximity of the site to a school. However, the appellant has provided a certificate to confirm that the proposal has been designed to comply

[1] Planning Practice Guidance - Paragraph: 008 Reference ID: 21b-008-20140306

with the guidelines published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). In these circumstances, the Framework advises that health safeguards are not something which a decision-maker should determine. No sufficiently authoritative evidence has been provided to indicate that the ICNIRP guidelines would not be complied with or that a departure from national policy would be justified.

17. Interested parties indicate that there are alternative sites available for the proposed mast. However, given my conclusion on the main issue it is unnecessary to address the merits of alternative sites. There is no requirement in the Framework or the GPDO 2015 to select the best feasible siting. In any event, this issue was not reflected in the Council's reason for refusal.

18. None of the other issues raised alter or outweigh my conclusion on the main issue.

Conditions

19. Any planning permission granted for the mast under Article 3(1) and Schedule 2, Part 16, Class A is subject to conditions set out in Paragraphs A.3(9), A.3(11) and A.2(2), which specify that the development must, except to the extent that the local planning authority otherwise agree in writing, be carried out in accordance with the details submitted with the application, must begin not later than the expiration of 5 years beginning with the date on which the local planning authority received the application, and must be removed as soon as reasonably practicable after it is no longer required for electronic communications purposes and the land restored to its condition before the development took place.

20. The Council has suggested that two additional planning conditions be imposed should approval be granted. However, the GPDO 2015 does not provide any specific authority for imposing additional conditions beyond the deemed conditions mentioned above and, in any event, the Council merely sought to require the implementation of the colour scheme indicated on the submitted details and the development to be carried out in accordance with the submitted plans. Consequently, I have not imposed those suggested conditions.

Conclusion

21. For the reasons given above, and having taken all other issues into account, I conclude that the appeal should be allowed and prior approval should be granted.

Andrew Bremford

INSPECTOR

The Planning Inspectorate

Appeal Decision

Site visit made on 15 March 2022

by Peter Mark Sturgess BSc (Hons), MBA, MRTPI

an Inspector appointed by the Secretary of State

Decision date: 25 March 2022

Appeal Ref: APP/K2610/W/21/3280694
Dussindale Drive, Thorpe St Andrew, Norwich, NR7 0WY

- The appeal is made under section 78 of the Town and Country Planning Act 1990 against a refusal to grant approval required under article 3(1) and Schedule 2, Part 16, Class A of the Town and Country Planning (General Permitted Development)(England) Order 2015 (as amended).
- The appeal is made by Mobile Broadband Network Limited against the decision of Broadland District Council.
- The application Ref 20210064, dated 12 January 2021, was refused by notice dated 9 March 2021.
- The development proposed is the installation of a 17.5 metre-high telecommunications monopole, accommodating 6no antenna apertures and a wraparound cabinet at its base; 6no ground-based equipment cabinet; plus, development ancillary thereto. As part of this proposal, two existing installations will be removed from the surrounding area, ensuring a net decrease in telecommunications base stations.

Decision

1. The appeal is allowed, and approval is granted under the provisions of Article 3(1), Schedule 2, Part 16, Class A of the Town and Country Planning (General Permitted Development)(England) Order 2015 (as amended) for the siting and appearance of installation of a 17.5 metre-high telecommunications monopole, accommodating 6no antenna apertures and a wraparound cabinet; plus, development ancillary thereto and as part of this proposal, two existing installations will be removed from the surrounding area, ensuring a net decrease in telecommunications base stations, on land at Dussindale Drive, Thorpe St Andrew, Norwich, NR7 0WY in accordance with the terms of planning application, Ref:20210064 dated 12 January 2021, the associated requirements of the above Order and the plans submitted with it including 150 Existing Elevation A, 002 Site location Plan, 100 Existing Site Plan, 215 Max Configuration Site Plan, 265 Max Configuration Elevation and the details contained in the industry site specific supplementary information.

Procedural Matters

2. The provisions of the Town and Country Planning (General Permitted Development)(England) Order 2015 as amended (GPDO 2015), under Article 3(1) and Schedule 2, Part 16, Class A, Paragraph A.3(4) require the local planning authority to assess the proposed development solely on the basis of its siting and appearance, taking into account any representations received. My determination has been made on the same basis.

3. I note in his statement the appellant's agent has raised the matter of the identity of the applicant/appellant. It is clear to me from the planning

application form and the appeal form that the original application and the appeal have been lodged by the same company/person as is required by the legislation. I therefore have determined this appeal on the basis that Mobile Broadband Network Limited is the appellant.

Planning Policy

4. The principle of development is established by the GPDO 2015 and the provisions of Schedule 2, Part 16, Class A of the GDPO 2015 do not require regard to be had to the development plan. I have had regard to the policies of the development plan and the National Planning Policy Framework (the Framework) only in so far as they are a material consideration relevant to matters of siting and appearance.

Main Issues

5. The main issues in this appeal are the effect of the siting and appearance of the proposed installation on the character and appearance of the area and the living conditions of neighbouring residential occupiers.

Reasons

Character and appearance

6. The site lies at the side of a distributor road that serves a large modern housing development. The road itself is approximately 6m wide with verges on each side of around 8 to 9ms that accommodate a grassed area (nearest to the road) and a footpath and cycle path.

7. The housing along, but not fronting, the distributor road is set back behind fences, walls, and mature hedges. The road falls from the appeal site to a roundabout some distance away. All the houses appear to be of traditional brick and tile construction. The grass verge accommodates street lighting columns, and some distance away, further telecoms infrastructure including masts and cabinets.

8. The appeal proposal would introduce a relatively slim mast of around 17.5m high together with 6 equipment cabinets on to the grass verge between the cycle path/footpath and the road. The mast would be taller than the existing masts in the area and taller than the houses and street lighting columns. However due to its design and the configuration of its antennas it would present at slim profile to the street. It is proposed that the column would also be finished in a light grey colour.

9. Therefore, whilst it would be tall, its prominence would be limited due to its slim profile and its colour. Whilst it would be visible from the roundabout some distance away it would not be viewed as an alien feature due to the presence of other masts and street lighting columns in the area.

10. The development plan for the area is comprised of the Joint Core Strategy for Broadland, Norwich, and South Norfolk (adopted in March 2011, amendments adopted in January 2014)(JCS) and the Development Management DPD of 2015 (DPD). I consider that the policies of the development plan that are relevant to this appeal are, Policies 2 of the JCS and Policy GC4 of the DPD. These policies seek, amongst other things, to ensure that new development

promotes local distinctiveness and pays regard to the environment and character of the area.

11. The character and appearance of the immediate area within which the appeal proposal is located is derived from its position along a main distributor road together, with street furniture such as lighting columns other, albeit shorter, telecommunication masts and cycleways, footways and grass verges. The installation of a further mast and cabinets would not therefore be wholly out of character with this location.

12. The mast would be significantly taller than others in the locality. However, due to its slim design and light grey colour it would be no more intrusive in the area than the other masts. I therefore consider that the proposal would be consistent with the policies of the development plan. Consequently, I do not consider that siting and appearance of the proposal would be incongruous in this location and therefore would not harm the areas character and appearance.

Living conditions of the occupiers of neighbouring properties

13. At the location where the mast is proposed to be located there are houses which face onto, but are not accessed from, Dussindale Drive. These houses are set behind hedges and fences and separated from the proposed site of the mast by a cycleway and footpath. They also have front gardens and drives between the front elevation of the house and the cycleway and footpath. The proposed equipment cabinets would not be visible from these houses. However, the mast would be visible from the windows of their front elevations.

14. Policy GC4 of the DPD seeks, amongst other things, to consider *'the impact upon the amenity of existing properties'* of new development. Whilst the proposed mast is significantly taller than other street fixtures in the area it has a slim profile and will be finished in a light grey colour. It is also set off the boundary with existing residential properties with a cycleway and footpath in between the proposed site and the boundary of the houses. In these respects, it is therefore consistent with Policy CG4 of the DPD.

15. Moreover, the residential properties have front gardens and drives between their front elevations and their boundaries. Consequently, given the slim profile of the mast, its light grey colour, and its distance from the front elevations of nearby properties I do not consider that its siting and appearance would unacceptably harm the outlook of the occupiers of these properties.

Other Matters

16. The matter of road safety has been referred to. It appears to me that these matters relate to the proximity of what is described as a well-used crossing point in the vicinity of the appeal site. This crossing point will be separated from the site of the proposed masts and cabinets by a short area of grass verge and is on a straight stretch of road with a 30mph speed limit. It is also apparent from the plans supplied with the proposal that the cabinets themselves and the mast will be set back from the edge of the carriageway. Consequently, I do not consider that siting of the appeal proposal would have an unacceptable impact on road safety in the area as adequate visibility can be maintained between pedestrians and vehicles using the road.

17. Concerns have been raised about the potential effects on health. However, the appellant has provided a certificate to confirm that the proposal has been designed to comply with the guidelines published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). In these circumstances, the Framework advises that health safeguards are not something which the decision maker should determine. No sufficiently authoritative evidence has been provided to indicate that the ICNIRP guidelines would not be complied with or that a departure from national policy would be justified.

18. With regard to the proliferation of telecommunications equipment in the area, I note that there are other masts and cabinets along Dussindale Drive. However, these are some distance from the appeal site and, as part of this proposal, it is proposed that a mast and cabinet around 75m from the appeal site will be removed. As a result of the separation between the existing telecommunications equipment and the appeal proposal and the proposal to remove an existing mast and cabinet, I do not consider that the proliferation of telecommunications equipment brought about by the siting of the appeal proposal will unacceptably harm the character and appearance of the locality.

19. I note that the matter of noise emitted from the cabinets has been raised as an issue. Whilst I understand that noise might be emitted from the cabinets this would be at a relatively low level. Moreover, given the distance from nearby houses and the ambient noise generated by the road and other activities in the area I do not consider that noise generated by the cabinets would unacceptably harm the living conditions of nearby residential occupiers.

20. Representations have referred to the opportunity of the appellants to use alternative sites to accommodate the appeal proposal. Whilst I have taken account of these matters, I consider, for the reasons given above, that the siting and appearance of the proposed installations to be acceptable in terms of its effect on the character and appearance of the area and on the living conditions of neighbours. Consequently, I am not obliged to consider alternative locations for the installation in this case.

Conditions

21. The Order does not provide any specific authority for imposing additional conditions beyond the deemed conditions for development by electronic communications code operators contained within it. These specify that the development must be carried out in accordance with the details submitted with the application, begin within 5 years of the date of the approval and be removed as soon as reasonably practical after it is no longer required for electronic communications purposes and the land restored to its condition before the development took place.

Conclusion

22. For the reasons given about I conclude that the appeal should be allowed, and prior approval should be granted.

Peter Mark Sturgess

INSPECTOR

The Planning Inspectorate

Appeal Decision

Site Visit made on 11 October 2021

by Martin Chandler BSc, MA, MRTPI

an Inspector appointed by the Secretary of State

Decision date: 1 November 2021

Appeal Ref: APP/R5510/W/21/3269903
Cowley Business Park, Uxbridge UB8 2AD

- The appeal is made under section 78 of the Town and Country Planning Act 1990 against a refusal to grant approval required under a Schedule 2, Part 16, Class A of the Town and Country Planning (General Permitted Development) (England) Order 2015 (as amended).
- The appeal is made by MBNL (EE UK Ltd & H3G UK Ltd) against the decision of London Borough of Hillingdon.
- The application Ref 74118/APP/2020/3119, dated 1 October 2020, was refused by notice dated 20 November 2020.
- The development proposed is Installation of a 20m high monopole supporting 12no antenna apertures & 2no 300mm dishes; installation of 8no cabinets; ancillary development thereto.

Decision

1. The appeal is allowed and approval is granted under the provisions of Article 3(1) and Schedule 2, Part 16, Class A of the Town and Country Planning (General Permitted Development) (England) Order 2015 (as amended) for the siting and appearance of the Installation of a 20m high monopole supporting 12no antenna apertures & 2no 300mm dishes; installation of 8no cabinets; ancillary development thereto, at Cowley Business Park, Uxbridge UB8 2AD, in accordance with the terms of application Ref: 74118/APP/2020/3119, dated 1 October 2020, and the plans submitted with it.

Preliminary Matters

2. Following the submission of the appeal, a revised National Planning Policy Framework (the Framework) was published. The parties were consulted in relation to this matter, and any responses received have been factored into my assessment of the appeal.

3. In refusing planning permission, the Council stated that due to the absence of a red line boundary around the edge of the development site from the entrance to the public highway, it was not possible to determine the full extent of the area of landscaping, trees and hedging that could be lost due to the construction of the development. However, in my judgement, the package of information that supports the proposal makes it very clear where the development would be sited. Accordingly, I am satisfied that the information provided to supplement the original application complied with the requirements of Paragraph A.3 (5) (a), within Class A, Part 16, Schedule 2 of the Town and Country Planning (General Permitted Development) (England) Order 2015 (as amended) (the 2015 GPDO). I will therefore proceed to assess the appeal on this basis.

Planning Policy

4. The principle of development is established by the 2015 GPDO and the provisions of Schedule 2, Part 16, Class A of the 2015 GPDO do not require regard be had to the development plan. Consequently, I have had regard to the policies of the development plan and the Framework only in so far as they are a material consideration relevant to matters of siting and appearance.

Main Issue

5. The main issue is the effect of the siting and appearance of the proposed development on the surrounding area, and whether any harm caused would be outweighed by the need to site the installation in the proposed location, having regard to the potential availability of alternative sites, and the requirements of national policy.

Reasons

6. The appeal site is located adjacent to an access road that serves a business park. The road meanders next to the business park and is lined by pockets of green space as well as mature trees and well-established landscaping. Existing street furniture in the immediate surroundings principally consists of lampposts and these are demonstrably subservient in height to the dominant trees. The greenery provided by the land associated with the appeal site, as well as the other frequent examples of similar pockets of greenery play an important role in providing a landscaped setting for the large and imposing business park. Accordingly, in its current form, the appeal site makes a positive contribution to the character and appearance of the surrounding area.

7. The proposal would introduce six cabinets onto the site as well as a monopole that would be 20 metres in height. Based on the evidence before me, the height of the monopole would be substantially taller than the mature trees which bound the site. Accordingly, it would represent a significant departure from the established height of existing lampposts with the height of the proposed structure representing a visually dominant addition to the existing environment. Due to the substantial height of the monopole, and plethora of associated cabinets, the proposal would detract from the pleasing greenery within which it would be located. This would harm the established landscape feature which positively contributes to the surrounding area as well as causing some harm to the visual amenities of surrounding properties, particularly those within converted office premises.

8. The proposal would also be located relatively close to three Grade II Listed Buildings. However, because the proposal does not seek planning permission or permission in principle, the duty established within Section 66 of the Planning (Listed Buildings and Conservation Areas) Act 1990, does not apply to this proposal. Despite this, the Framework still requires the heritage implications to be fully considered.

9. The setting of the nearby listed buildings has been substantially altered over time, particularly with the construction of the nearby business park. However, the landscaped buffer to which the appeal site contributes, plays an important role in softening the setting of the buildings. For the reasons identified above, the proposal would have a harmful effect on the established landscaping. Despite this, the appeal site is not immediately adjacent to the listed buildings,

and much of the landscaped buffer would be retained by the proposal. Consequently, in my judgement, the proposal would have a very limited negative effect on the setting of the listed buildings. On this basis, Paragraph 202 of the Framework confirms that where a proposal would lead to less than substantial harm to the significance of a designated heritage asset, the harm should be weighed against the public benefits of the proposal.

10. Paragraph 114 of the Framework confirms that advanced, high quality and reliable communications infrastructure is essential for economic growth and social well-being, and that planning policies and decisions should support the expansion of electronic communication networks, including next generation mobile technology.

11. Based on the evidence before me, the proposal would replace an existing installation that is based on the rooftop of the Brunel University Engineering Block. The evidence implies that this installation is in danger of being lost from the network for reasons beyond the Operator's control, and that the proposal would prevent any loss of service when the existing base station is removed. The details in relation to this matter are sparce within the evidence, however, Paragraph 118 of the Framework confirms that the need for an electronic communications system should not be questioned. Accordingly, I do not dispute the need for the proposal. Moreover, due to the economic and social benefits that the proposal would provide, substantial weight is given to these matters.

12. The evidence also confirms that the design of the proposal would be such that the monopole would be of the smallest dimensions possible without compromising operational efficiency. In addition, it is confirmed that 13 alternative sites were considered to replace the existing installation but that these were discounted primarily in relation to coverage issues, although other physical constraints were also identified.

13. Accordingly, although the siting and appearance of the proposed development would cause some limited harm to the setting of the nearby listed buildings, I am satisfied that the economic and social benefits of the proposal, would outweigh this harm. I am also satisfied that the appellant has suitably considered the availability of alternative sites and discounted them for appropriate reasons. Consequently, having regard to the potential availability of alternative sites, as well as the requirements of national policy, I conclude that the harm caused by the proposal would be outweighed by the need to site the installation in the location proposed.

Conditions

14. Any planning permission granted under Article 3(1) and Schedule 2, Part 16, Class A is subject to conditions set out in Paragraphs A.3(9), A.3(11) and A.2(2), which specify that the development must, except to the extent that the local planning authority otherwise agree in writing, be carried out in accordance with the details submitted with the application, must begin not later than the expiration of 5 years beginning with the date on which the local planning authority received the application, and must be removed as soon as reasonably practicable after it is no longer required for electronic communications purposes and the land restored to its condition before the development took place.

Conclusion

15. For the reasons identified above, the appeal should be allowed, and prior approval should be granted.

Martin Chandler

INSPECTOR

The Planning Inspectorate

Appeal Decision

Site visit made on 11 May 2021

by J Ayres BA Hons, Solicitor

an Inspector appointed by the Secretary of State

Decision date: 11 June 2021

Appeal Ref: APP/E2205/W/20/3261389
A252 A28, Chilham CT4 8DU

- The appeal is made under section 78 of the Town and Country Planning Act 1990 against a refusal to grant approval required under Article 3(1) and Schedule 2, Part 16, Class A of the Town and Country Planning (General Permitted Development) (England) Order 2015 (as amended).
- The appeal is made by Telefonica UK Limited against the decision of Ashford Borough Council.
- The application Ref 20/00305/AS, dated 28 February 2020, was refused by notice dated 20 April 2020.
- The development proposed is the erection of a 20m high monopole supporting 3no. antennas and 2no. 0.3mm dishes, the installation of 2no. equipment cabinets and 1no. meter cabinet on new base and the installation of ancillary equipment.

Decision

1. The appeal is allowed and approval is granted under the provisions of Article 3(1) and Schedule 2, Part 16, Class A of the Town and Country Planning (General Permitted Development) (England) Order 2015 (as amended) for the siting and appearance of the erection of a 20m high monopole supporting 3no. antennas and 2no. 0.3mm dishes, the installation of 2no. equipment cabinets and 1no. meter cabinet on new base and the installation of ancillary equipment at land at A252 A28, Chilham CT4 8DU in accordance with the terms of the application Ref 20/00305/AS, dated 28 February 2020, and the plans submitted with it.

Procedural Matter

2. The provisions of the Town and Country Planning (General Permitted Development) (England) Order 2015 as amended (GPDO 2015), under Article 3(1) and Schedule 2, Part 16, Class A, Paragraph A.3(4) require the local planning authority to assess the proposed development solely on the basis of its siting and appearance, taking into account any representations received. My determination of this appeal has been made on the same basis.

Planning Policy

3. The principle of development is established by the GPDO 2015 and the provisions of Schedule 2, Part 16, Class A of the GPDO 2015 do not require regard be had to the development plan. I have had regard to the policies of the development plan and the National Planning Policy Framework (Framework) only in so far as they are a material consideration relevant to matters of siting and appearance.

Main Issue

4. The main issue is the effect of the siting and appearance of the proposed installation on the character and appearance of the area having particular regard to the setting of the Grade II listed Bagham Farmhouse and Grade II listed Barn.

Reasons

5. Part 16 of the Order establishes that the proposal is permitted development and therefore it is accepted in principle by virtue of the legislation. Furthermore, there is no requirement to have regard to the development plan as there would be for any development requiring planning permission. Nevertheless, Policies SP1, SP6 and ENV13 of the Ashford Borough Council Local Plan to 2030 are material considerations as they relate to issues of siting and appearance. In particular, they seek to secure high quality design and to avoid development that would cause loss or substantial harm to the significance of heritage assets. Similarly, the National Planning Policy Framework is also a material consideration and this includes a section on supporting high quality communications.

6. The proposal would be located on a wide highway verge, close to a number of relatively tall trees. In the immediate and wider area there is various highway infrastructure including traffic signage, a crossing, and telegraph poles. The proposal would include a monopole which would support antennas and additional microwave dishes. Two equipment cabinets would be located next to the pole along with a meter cabinet. The monopole would be in a relatively prominent position in relation to the road; visible when approaching the site from either direction. However, it would be seen in the context of the other infrastructure in the area and, from some vantage points, to the back drop of the trees. I have no evidence that the trees are likely to be removed in the near future or that their longevity is otherwise at risk.

7. Further along the A28, on the opposite side of the road, is the Bagham Farmhouse and associated listed barn. Both are Grade II listed. They sit back from the highway, separated by a low stone wall and mature gardens. The setting of the listed buildings are experienced intimately through the entrance and garden area. The wider setting is one of the highway and adjacent more modern residential development adjacent to the listed buildings. The A28 is a highly trafficked road, which appears subject to a number of infrastructure elements along it, including areas of markings on the road itself.

8. The monopole would be taller than the other surrounding infrastructure, but, the context it would be seen in, along with the slim nature of the monopole and its proposed dark green colour, would be such that it would not be harmful to the intimate setting or the wider setting of the listed buildings. The existing tree cover adjacent to the appeal site, combined with the surrounding infrastructure would all serve to limit the views of the monopole in relation to the listed buildings, which come into view on the right as one rounds the corner of the A28. The pole would be more prominent when approaching with it on the left, however the listed buildings are a substantial distance from the appeal site, and it would not form a material aspect of the setting of the heritage asset.

9. Consequently, the proposed development would cause no material harm to the character and appearance of its surroundings more generally and does not amount to any irreversible physical harm to or loss of significance of a designated heritage asset. As such, I am satisfied that the appeal development would not be harmful to the designated heritage assets.

Other Matters

10. There is evidence that the proposal would result in significant improvements to the local 4G coverage and that the technical limitations are such that any search area is necessarily relatively restricted. The National Planning Policy Framework (the Framework) is clear that advanced, high quality, telecommunications are essential for sustainable economic growth. It also sets out that competition between operators should not be prevented, nor should the need for the telecommunications system be questioned.

11. I have regard to the alternative sites suggested. However, there is no substantive evidence that these sites would provide the necessary coverage or that the land owners would give permission for the development to be on their land. Overall, I am satisfied that the appellant has made sufficient attempts to find an alternative site that would perhaps have a lesser impact than the proposed, to no avail.

12. Concerns have been raised about the potential effects on health. However, the appellant has provided a certificate to confirm that the proposal has been designed to comply with the guidelines published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). In these circumstances the Framework advises that health safeguards are not something that a decision maker should determine. No sufficiently authoritative evidence has been provided to indicate that the ICNIP guidelines would not be complied with or that a departure from the Framework would be justified.

Conclusion and Conditions

13. The Framework indicates that advanced, high quality and reliable communications infrastructure is essential for economic growth and social wellbeing. The expansion of electronic communications networks should generally be supported. Equipment on new sites should be sympathetically designed and camouflaged where appropriate. I have found that the proposal would not result in harm to the setting of heritage assets or the area more generally and accordingly the appeal should succeed.

14. The Order does not provide any specific authority for imposing additional conditions beyond the deemed conditions for development by electronic communications code operators contained within it. These specify that the development must be carried out in accordance with the details submitted with the application, begin within 5 years of the date of the approval and be removed as soon as reasonably practicable after it is no longer required for electronic communications purposes and the land restored to its condition before the development took place.

15. For the reasons given, and having regard to the representations received, the appeal is allowed, and prior approval given.

J Ayres INSPECTOR

The Planning Inspectorate

Appeal Decision

Site Visit made on 18 May 2021

by J Williamson BSc (Hons) MPlan MRTPI

an Inspector appointed by the Secretary of State

Decision date: 10 June 2021

Appeal Ref: APP/J4423/W/21/3268791
Shirecliffe Road, Sheffield, S4 7DU

- The appeal is made under section 78 of the Town and Country Planning Act 1990 against a refusal to grant approval required under Schedule 2, Part 16, Class A of the Town and Country Planning (General Permitted Development) (England) Order 2015 as amended (the GPDO).
- The appeal is made by MBNL Limited against the decision of Sheffield City Council.
- The application Ref 20/03010/TEL, dated 2 September 2020, was refused by notice dated 23 October 2020.
- The development proposed is described as: Installation of a 20m high mast supporting communications apparatus, 9No. equipment housing cabinets at ground-level and ancillary works thereto.

Decision

1. The appeal is allowed, and approval is granted under the provisions of Schedule 2, Part 16, Class A of the Town and Country Planning (General Permitted Development) (England) Order 2015 as amended, for installation of a 20m high mast supporting communications apparatus, 9No. equipment housing cabinets at ground-level and ancillary works thereto at Shirecliffe Road, Sheffield S4 7DU, in accordance with application Ref 20/03010/TEL, dated 2 September 2020, and the associated requirements of the GPDO.

Preliminary Matters

2. The description of proposed development on the Council's decision notice differs to that on the application form. On the appeal form, the appellant has given the same description to that used on the application form and states that it has not changed. I have no evidence of the parties agreeing to a change of description. I have therefore made my decision based on the description of proposed development originally given on the application form, which I consider sufficiently describes the proposed works.

3. The provisions of the GPDO require the local planning authority to assess the proposed development solely based on its siting and appearance, taking account of any representations received. My determination of the appeal has been made on the same basis. I note that there is no definition of the terms siting and appearance in the GPDO or in extant national policy or guidance.

4. The principle of development is established by the GPDO. The provisions of Schedule 2, Part 16, Class A of the GPDO do not require regard to be had to the development plan. I have therefore only had regard to development plan policies in so far as they are material to matters of siting and appearance.

Main Issues

5. The main issues are:

   - whether the siting and appearance of the proposed development is acceptable with regards to its effect on the character or appearance of the area, and
   - if any harm is found, whether this is outweighed by the need to site the installation in the location proposed, having regard to the availability of suitable alternative sites.

Reasons

Character and appearance

6. The site is located within the footpath, just north of a bus shelter, on the eastern side of Shirecliffe Road, a road which runs through a designated housing area, as defined in the Sheffield Unitary Development Plan (UDP). There are dwellings on the opposite side of the road from the site which are two-storeys high. The land to the east of the site is lower than the footpath and comprises an open area accommodating several football pitches that form part of the training area of a local football club. The boundary between the open area to the east and the footpath consists of a grass verge, a fence around 2 m high and trees up to around 9 m high. There are slimline streetlamps along the eastern side of the road, around 10 m high, and a few telegraph poles, around 8-9 m high. There is also an existing telecommunications mast, around 12 m high, located around 12-15 m south of the bus shelter, with 5 or 6 associated ground level cabinets. Hence, even with the existing telecommunications mast, the area is characterised by low-level residential properties, low-level street furniture and open sports fields.

7. The proposed 20 m high monopole would be of a diameter much wider than the streetlamps along the road and it would have antennas sited on its upper part. The mast would tower above the adjacent boundary tree line, the street furniture, and residential properties in the area, being around twice the height of the highest of these features. The number of proposed cabinets, 9, would be extensive, resulting in a dense row of cabinets along the footpath's edge. The mast and the cabinets would be very prominent and highly visible within the street scene; and the mast would be seen from public vantage points beyond the immediate locality. I disagree with the appellant's assertion that the proposal would not look untoward within the context of the site. To my mind, given the extensive height of the mast and the substantial number of associated cabinets, regardless of the finishes that could be used on the surfaces of the equipment, I conclude that the siting and appearance of the proposal would significantly harm the street scene and the character and appearance of the area.

8. Although not determinative, in light of the above, the proposal would not accord with Policy CS74 of the Sheffield Development Framework Core Strategy-2009 or policies H14 and BE14 of the UDP; which, collectively, and among other things, require new development, including telecommunications equipment, to be well-designed, sited to minimise visual impact and to be in scale and in character with the area.

Alternative sites

9. Paragraph 113 of the Framework advises that the number of telecommunications masts and the sites for such installations should be kept to a minimum; and that the use of existing masts, buildings and other structures should be encouraged. It is also recognised in paragraph 113 that new sites may be required for the delivery of some services, such as 5G.

10. Paragraph 115 of the Framework advises that applications for electronic communications development, including applications for prior approval under the GPDO, should be supported by the necessary evidence to justify the proposed development. For a new mast or base station, this should include evidence that the applicant has explored the possibility of erecting antennas on existing buildings, masts, or other structures.

11. The site is a new site. The need for the site has arisen due to a base-station being decommissioned for reasons beyond the control of the operator. In addition to alternative sites initially discounted by the appellant, other alternative sites were considered at the request of Council Officers, and these were also discounted, due to not being suitable for several reasons.

12. In accordance with paragraph 116 of the Framework, the Council does not question the need for the proposal, and I have no grounds for doing so either. The Council also appreciate that the mast needs to be of a "certain height" to ensure suitable coverage is achieved. Additionally, as the appellant provided a response to the Council's suggestion of considering other alternative sites, the Council appears to accept that the appellant has considered other feasible options but that no suitable alternative exists. I am satisfied that the appellant has demonstrated that there are no suitable alternative sites that would be more favourable in respect of the effect of the proposal on character and appearance. This factor therefore weighs heavily in favour of the proposal.

Other Considerations

13. Paragraph 80 of the Framework advises that significant weight should be attached to the economic benefits of providing and enhancing electronic communications infrastructure. Paragraph 112 advises that advanced, high quality and reliable communications infrastructure is essential for economic growth and social well-being, and that the expansion of electronic communications networks, including next generation mobile technology, such as 5G, should be supported.

14. The proposal would reinstate 2G, 3G and 4G coverage within the area as well as providing 5G coverage, services would collectively increase network capacity and provide ultra-fast and more reliable mobile connectivity, capable of handling ever-increasing data requirements. The development would provide extensive social and economic benefits to individuals, businesses, and public services, including education and healthcare. The Council does not question the social and economic benefits that would result from the proposal but concludes that they do not outweigh the harm found. However, as no suitable alternative sites have been identified, I attach substantial weight to the benefits that would result from the proposal.

15. In weighing all the above matters, although I have found that the siting and appearance of the proposal would significantly harm the character and

appearance of the area, I consider the substantial social and economic benefits of the proposal outweigh the harm identified.

Conditions

16. The permission granted for the development under Article 3(1) and Schedule 2, Part 16, Class A is subject to conditions set out in Paragraphs A.3(9)(b), A.3(11)(b) and A.2(2)(ii) of the GPDO, which specify that the development must, except to the extent that the local planning authority otherwise agree in writing, be carried out in accordance with the details submitted with the application, must begin not later than the expiration of 5 years beginning with the date on which the local planning authority received the application, and must be removed as soon as reasonably practicable after it is no longer required for electronic communications purposes and the land restored to its condition before the development took place.

Conclusion

17. For the reasons outlined above, I conclude that the appeal is allowed, and prior approval is granted.

J Williamson

INSPECTOR

The Planning Inspectorate

Appeal Decision

Site visit made on 12 April 2016

by G Fort BA PGDip LLM MCD MRTPI

an Inspector appointed by the Secretary of State for Communities and Local Government

Decision date: 24 May 2016

Appeal Ref: APP/Q5300/W/16/3142885
Hadley Wood Station, Crescent West, Hadley Wood, Barnet EN4 0EL

- The appeal is made under section 78 of the Town and Country Planning Act 1990 against a refusal to grant planning permission.
- The appeal is made by CTIL and Telefonica UK Limited against the decision of the Council of the London Borough of Enfield.
- The application Ref 15/02500/FUL, dated 2 June 2015, was refused by notice dated 5 August 2015.
- The development is described as " the installation of a 20m cypress tree supporting 6 no. antennas and 2 no. 300mm dishes along with 4 no. ground based cabinets with development ancillary thereto all to be enclosed within a fenced compound measuring 4.10m x 7.825m."

Decision

1. The appeal is allowed and planning permission is granted for the installation of a 20m cypress tree supporting 6 no. antennas and 2 no. 300mm dishes along with 4 no. ground based cabinets with development ancillary thereto all to be enclosed within a fenced compound measuring 4.10m x 7.825m at Hadley Wood Station, Crescent West, Hadley Wood, Barnet EN4 0EL in accordance with the terms of the application, Ref 15/02500/FUL, dated 2 June 2015, subject to the conditions in the schedule to this decision.

Main Issues

2. The main issues in this appeal are the effects of the proposal on the character and appearance of the surrounding area and adjacent Green Belt, and whether any harm caused is outweighed by the need to site the installation in the location proposed.

Reasons

3. The appeal site is a small roughly triangular service yard adjoining the platform of Hadley Wood Station. Fringed by sparsely planted deciduous trees to the rear, and more dense vegetation to its side, the yard is open to views from the platforms and passing trains. From the platforms, the yard is viewed in the surrounding functional context of railway lines, the regularly-spaced rows of lamp-posts, and other vertical railway structures. To the rear, the appeal site is bounded by a public footpath, which marks the boundary of the Metropolitan Green Belt (MGB), and beyond that open playing fields. The Hadley Wood Conservation Area boundary lies along the road to the front of the station.

4. The appeal scheme would introduce telecommunications equipment within the service yard, the most visible element of which would be the 20m high pole that would have the appearance of a cypress tree. The proposal would site lower rise related development in the yard including 4 cabinets of a height of just over 1.5m and fencing enclosing the equipment of around 1.8m in height.

5. At the time of my site visit the trees fringing the appeal site were not yet fully in leaf, combined with their sparse planting, this would mean that the proposed cypress would be prominent and visible in very localised views from the footpath and the immediately adjacent playing field. Furthermore, due to its siting and dislocation from the surrounding tree cover the proposal would look incongruous within the open and functional surroundings of the railway platform, where it would be apparent that it was an item of telecommunications equipment disguised as a tree.

6. I have fewer concerns about the proposal's visual effects in longer range views, and during times of the year when the trees are in fuller leaf. I saw that from the adjacent public footpath, which sloped upwards along its course away from the station yard, the proposal would gradually blend into the wider tree cover visible in longer range views to the south of the station, and would not in this context appear unduly incongruous or visually harmful. In longer range views from the MGB, the undulating terrain and intervening trees would reduce the proposal's visibility.

7. From Crescent West, intervening buildings, the parapet wall of the railway bridge and tree cover would all reduce the visual effect of the proposal. It would only be viewed in glimpses if at all, most notably over the boundary of Gables Lodge adjacent to the railway bridge. In any event, most views of the proposal glimpsed from the crescent would be against a backdrop of mature trees, and it would thus not look incongruous. As this thoroughfare marks the boundary of the Hadley Wood Conservation Area the proposal would thus have a minimal effect on its setting. Consequently, the proposal would be of no harm to the character, appearance or significance of the conservation area.

8. In terms of the low-rise cabinets and fencing that the proposal would introduce on to the site, these are of a scale and character that would not look incongruous within the functional surroundings of the railway station. Thus I do not consider that any harmful effects to the area's character and appearance would flow from the installation of these low-rise structures.

9. Consequently, I consider that the proposal would not cause harm to the character or appearance of either the conservation area or that of the adjacent MGB. Its principal harm to character and appearance would be extremely localised and within the context of the immediate functional and engineered environs of the station, where due to the mast's design, and its dislocation from the surrounding vegetation, it would look incongruous.

10. Given this minor harm to the character and appearance of the station arising from the design and siting of the proposed mast, I am mindful of the guidance of the National Planning Policy Framework (the Framework), which states that local planning authorities should "aim to keep the numbers of radio and telecommunications masts and the sites for such installations to a minimum consistent with the efficient operation of the network. Existing masts, buildings and other structures should be used unless the need for a new site is justified".

11. The appellants submitted evidence in regard to their consideration of the suitability of other sites. The owner of 14 Crescent West, which currently hosts telecommunications equipment, did not want any further such development. Neither did the lawn tennis club on the opposite side of the railway to the station yard express an interest in accommodating such an installation. Other sites considered would be closer to residential properties, and one would have had a greater effect on the character and appearance of the conservation area. Furthermore, an alternative site suggested as part of the consultation process would be within the MGB itself, and thus would be of demonstrable harm to its openness.

12. I am thus persuaded that alternative sites were considered and that best endeavours were made to co-locate the proposal alongside existing equipment. Moreover, the appellant also submitted evidence of a previous appeal decision[1], which established the principle that the station yard would be suitable for a telecommunications installation. Whilst the siting and design of this previous scheme differ to those of the current proposal, its height would have been the same.

13. Although the proposal would appear incongruous within the immediate station environment, I am mindful of the Framework which states that "Where new sites are required, equipment should be sympathetically designed and camouflaged where appropriate". I have also had regard to the appellants' suggestion that the design of the mast and the type of tree employed could be subject to a condition. Consequently, whilst the proposed tree effect for the mast would look a little disjointed within the station yard itself, its camouflage would reduce the mast's visual effects in the context of longer range and more sensitive views from both the conservation area and the open surroundings of the adjacent MGB.

14. I have had regard to the Framework's guidance at paragraphs 6-7, which state that the purpose of the planning system is to contribute towards the three dimensions of sustainable development, namely the economic, social and environmental. In considering the scheme I have had regard to the evidence submitted by the appellants that demonstrates the significant improvement to mobile phone 2g, 3g and 4g network coverage that would be achieved for both the residents of Hadley Wood and train passengers. The proposal would thus have demonstrable economic and social benefits, through facilitating digital connectivity for both employment and social purposes. Moreover, through enabling home working the proposal could have positive environmental effects by reducing the necessity for people to commute.

15. Consequently, the appeal scheme would provide demonstrable economic and social benefits that would outweigh its minor effects on the character and appearance of the station. The proposal, due to its lack of significantly harmful visual effects on the character and appearance of the adjacent MGB would not conflict with the CP33 of the Enfield Core Strategy (adopted November 2010) ("the Core Strategy") or Policy DMD 83 of the Enfield Development Management Development Plan Document (adopted November 2014) ("the DMDPD"). Whilst I detect some conflict with the objectives of CP30 of the Core Strategy and DMD37 of the DMDPD, I have given greater weight to the Framework in these regards as the proposal's minor harms to the immediate

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character and appearance of the station are outweighed by its substantial economic and social benefits, and an appropriate condition could considerably soften any harmful visual effects.

Other Matters

16. I note concerns with the potential exposure to high winds of this tall structure adjacent to a railway line, but I have no evidence before me to suggest that it would be of a specification susceptible to collapse. Similarly, I am mindful of concerns about safety of the footpath during the construction of the appeal scheme, however, I have no reason to doubt that the developers of the scheme would abide by the relevant statutory codes in relation to health and safety and construction site management, which would mitigate any risks in this regard.

17. I had regard to the suggestion that a smaller mast could be developed at the site to serve only rail passengers and that a further mast could be developed elsewhere to serve Hadley Wood residents more generally. However, I find the appellants' evidence showing a general lack of other suitable sites persuasive in this regard. I also consider that evidence of the enhanced coverage achieved by the proposal which was submitted with the appeal documents is demonstrative of the mast's potential to boost network access across Hadley Wood and not just to rail passengers, and I have been supplied with no substantive evidence that would contradict this.

18. I note the willingness of respondents to have more dialogue with the developers about siting of telecommunications infrastructure, but have also had regard to the pre-application involvement in this scheme, that resulted in some changes, not least the proposal to camouflage the mast to soften its visual effects in long range views.

19. I considered the proposal's potential effects on providing step free access to the railway station. The precise details of the step free access scheme are not before me in this appeal. Moreover, this is essentially a matter for the landowner to determine as part of its ongoing management of the site. For these reasons this consideration has not been determinative in my consideration of the appeal. Similarly, that the yard is currently in frequent use and that the proposal may interfere with this is essentially a matter for the landowner, and not one that is instrumental in my consideration of the appeal.

20. I had regard to the suggestion that the playing field is a sensitive location, and some previous appeal decisions on mast schemes were referred to concerning potential effects on such sites. However, the substance of these decisions was not before me and in the absence of further details I am unable to attach them substantial weight in my assessment of the current appeal. Whilst the playing fields may be well-used, I am mindful of the Declaration of Conformity with ICNIRP Public Exposure Guidelines, which ensures that the proposal complies with paragraph 46 of the Framework as regards to the proposal's potential health impacts.

21. The proposal may be visible from windows of residential properties. However, due to the separation distances achieved between it and the nearest dwellings and its relatively slim profile at higher level, it could not be said to constitute an overbearing structure that would be unduly harmful to outlook. In terms of the proposal's effects on private views, these are matters that the Courts have

held can rarely be instrumental in planning decisions, and as such I only attach very limited weight to these considerations in arriving at my decision.

Conditions

22. I have assessed the planning conditions submitted by the Council, and the one suggested by the appellant against the criteria contained in paragraph 206 of the Framework.

23. I have attached the standard implementation condition in the interests of the proper planning of the area and to comply with the requirements of the Town and Country Planning Act 1990 (as amended). In the interests of certainty, I have attached a condition requiring the development to be implemented in line with the approved plans. In order that the mast is as sensitive as possible to its immediate environs, I have attached a condition regarding submission and approval of details to be employed in the development, as suggested by the appellant.

Conclusion

24. Whilst I have detected some minor harm to the character and appearance of the proposal's immediate environment by way of its visual incongruity, this harm is clearly outweighed by the appeal scheme's considerable social and economic benefits, and modest though demonstrable environmental benefits.

25. The appeal scheme would thus constitute sustainable development for the purposes of the Framework. This consideration would outweigh the minor conflict with the policies of the development plan insofar as they have been brought to my attention. Accordingly, for the reasons given above, and having regard to all other matters raised, I conclude that the appeal should succeed.

G Fort

INSPECTOR

SCHEDULE OF CONDITIONS

1) The development hereby permitted shall begin not later than three years from the date of this decision.

2) The development hereby permitted shall be carried out in accordance with the following approved plans: Site Location Plans (drawing no.100) dated 17.07.14; Lease Demise (drawing no.101) dated 17.07.14; Proposed Site Plan (drawing no. 200) dated 17.07.14; Proposed North East Elevation (drawing no. 101) dated 17.07.14.

3) Notwithstanding condition (2) no development shall take place until details of the proposed mast tree type have been submitted to and approved writing by the local planning authority. Development shall be carried out in accordance with the approved details.