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Greater Exeter Digital Connectivity Strategy

Prepared by Adroit Economics

For and on behalf of

Greater Exeter Local Authorities

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1. Introduction

- 1.1 The Greater Exeter local authorities commissioned the Adroit Economics Consortium¹ to formulate a forward-looking digital connectivity strategy for the city-region. The strategy is intended to provide a framework for both immediate but also longer term local authority initiatives – and – will provide the basis for inclusion of digital connectivity policy in the land use planning process, through inclusion of policy in the GESP.
- 1.2 This document sets out the proposed GE digital strategy, followed by the detailed research and analysis undertaken to support the strategy.
- 1.3 If you have any questions or require further information, please do not hesitate to contact the authors:

- Dr Steve Sheppard, CEO, Adroit Economics

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¹ Comprising Adroit Economics, Point Topic, Quod and NovacQC

2. Executive Summary – summary of the baseline

2.1 This report includes two executive summaries:

- A summary of the baseline work undertaken – identification of digital connectivity targets; mapping of current and likely future network investment and consequent availability of services; matching these against targets to identify the nature and extent of gaps
- A summary of the rationale for and the themes and actions proposed for a GE digital connectivity strategy, designed to put in place local measures to address the gaps identified in the baseline work

2.2 This chapter provides a summary of the baseline, and of the work undertaken to assess the baseline

Digital connectivity targets for GE

2.3 We recommend that GE's digital connectivity targets reflect the UK Government's latest digital connectivity targets, which focus on promoting and accelerating investment in local full fibre network by a multiplicity of providers to encourage and stimulate competition at all levels of the digital connectivity supply chain.

The UK's Government's digital connectivity targets

2.4 Two main types of digital connectivity service have evolved

- Broadband to the premises – via **fixed line** (and wireless point to point) networks
- Broadband (data services) to mobile devices via the **GSM** networks – e.g. mobile phone networks, (which also include data services in addition to voice)

Fixed line market

2.5 There are two distinct types of fixed-line product/service and associated markets, with very different supply chains, value chains, network technologies, quality of service and pricing

- Consumer broadband services – public policy tends to focus on promoting consumer broadband targets speed and availability targets
- Lease line services – public policy tends to focus on regulation/deregulation measures to promote competition, rather than speed targets

Consumer broadband

2.6 Current (and future targets) in the UK comprise a combination of speed (usually Mbps download speed), wider service quality and, of recent, technology metrics. Current targets are best illustrated by Ofcom's open access market review which identifies three principal fixed line consumer broadband targets

- **standard broadband:** download speeds of up to 30 Mbit/s;
- **superfast broadband:** download speeds from 30 Mbit/s up to 300 Mbit/s; and
- **ultrafast broadband:** download speeds of 300 Mbit/s and above Superfast broadband take-up is growing rapidly, and where it is available 47% of broadband lines were at superfast speeds by mid-2016.

2.7 Ofcom notes though that there is no standard definition of ultrafast. The UK Government currently defines ultrafast as 100 Mbit/s or greater. Ofcom considers that the reliability with which the speed is delivered is an important attribute and expects the definition of ultrafast to evolve to take account of the importance of this reliability. Ofcom currently takes ultrafast broadband services to be those that

offer a minimum download speed of 300 Mbit/s or more (a factor of ten greater than that offered by superfast). These services also offer higher upload speeds than superfast broadband. Over time Ofcom expects ultrafast technologies to evolve towards providing gigabit speeds and above – 1 Gbit/s or more

- 2.8 Since Autumn 2017, the UK Government is, for the first time, promoting a particular network technology in association with ultrafast targets, namely fibre optic cable. The Government has recently shifted its focus to identifying ways to get the private sector to invest more in infrastructure – both fixed line and mobile – that can meet medium-to-long term projections of increasing use – with specific emphasis on fibre². This points clearly to the need to establish ‘full fibre’ connectivity in a variety of configurations both as the principal long-term delivery medium for domestic and business premises, and to underpin investment in 5G mobile networks, which are anticipated to offer much higher throughput of data, with a concomitant demand for much more backhaul. Policy, as a consequence, is now technology specific. Quoting from Ofcom’s current **Strategic Review of Digital Communications**, *one of our objectives is to make a strategic shift to encourage the large-scale deployment of new ultrafast broadband networks, including fibre direct to homes and businesses (sometimes called ‘full-fibre’), as an alternative to the predominantly copper-based technologies deployed to date by Openreach. Full-fibre networks support very high speeds, ranging from several hundred Mbps to 10 Gbps or more, and should be more reliable*³.

- 2.9 Technologies that will be able to deliver ultrafast services are likely to include:

- Full fibre networks – fibre to the premises
- G-fast enabled legacy copper networks – the latest in a long line of copper network data transmission technologies that increase the speeds that can be delivered over the legacy copper network
- Virgin’s Project Lightning – increasing speeds over the cable TV network

Area coverage targets

- 2.10 Various area coverage targets have been set for standard and superfast – aiming at 90-95% or more coverage, but no area coverage targets have been set for ultrafast. Instead the focus is on policy measures to increase investment by, and competition between, providers, allowing the market, supported by occasional injections of grant funding and public-private initiatives, to drive and dictate the rate and extent of new investment.

Universal Service Obligation for broadband

- 2.11 In addition to the above consumer broadband targets, also for the first time, the Government is in the process of implementing a USO for broadband at 10 Mbps. It is not yet clear who and how this will be delivered but the aim is to ensure that all those that cannot access standard broadband or better, can at the very least access 10 Mbps download speed via a USO

² Fibre optic network, from door to door, is widely recognised as the optimum network architecture in that it can handle very high bandwidths, symmetrically and can provide very high quality of service. It is expensive however to install. For this reason, a number of countries have focussed on gap funding the incumbents to use and extend legacy copper networks to deliver consumer broadband. Others have however focussed on promoting wide scale fibre deployment. The recent shift in UK government policy recognises that the UK is potentially lagging behind these countries because of our past focus on investing in legacy copper networks as opposed to promoting wide scale fibre deployment, and that it is time to change this and to focus on promoting fibre network deployment in order to catch up competitive advantage

³ <https://www.ofcom.org.uk/consultations-and-statements/category-1/wholesale-local-access-market-review>

Recommendation - GE consumer broadband fixed-line targets

Given that the GE digital connectivity strategy is intended to be forward looking, over the next, 10, 20 to 30 years, and to underpin digital connectivity objectives in the GESp, we recommend that GE focusses on ultra-fast targets, and specifically on local full fibre network targets – namely to put in place a full mix of measures that will support, enable and deliver increased investment in local full fibre networks through a variety of providers and/or through open access networks in order to optimize competition and innovation in service delivery at all levels of the digital connectivity supply chain

Lease line services

- 2.12 There is no explicit target for lease line services, instead the presumption is that increasing investment in local full fibre network infrastructure will reduce connection costs for those wanting bespoke lease line services, and, will increase service provider choice and competition, resulting in more competitive pricing. Of equal if not more significance, increasing provision of consumer broadband services delivered over local full fibre networks, will encourage/enable many existing lease line users to migrate to lower cost consumer broadband services

Mobile and wireless services targets for GE**4G mobile targets**

- 2.13 The aspiration is for full coverage with interoperability between cells operated by different providers. Achieving these targets is partly dependant on further regulatory change, which is unlikely to be immediately forthcoming. It's a very difficult policy area (see the main chapter for an explanation)

5G mobile targets

- 2.14 Instead mobile policy is shifting in focus towards the future, as yet still developmental 5G mobile service platform, anticipated to be ready for large scale commercial rollout early in the next decade. This is dependent on 5G becoming a viable commercial technology, on industry investment appetite, on a favourable national regulatory environment, on favourable local planning and highways policy environment – and last, but by no means least, wide scale deployment of local full fibre access network, including in rural areas, required to support the much higher data rates predicted for 5G, providing backhaul to the much larger number of masts, dishes, antenna, aerals anticipated to be required to support a 5G service. 5G services are anticipated to do at least four things (i) provide much faster data access to mobile devices (smart phones, tablets etc) (ii) support smart city/ smart settlement operations, for example such as assisted vehicle technology (iii) support smart industry through a plethora of as yet unidentified applications, and (iv) in conjunction with Wi-Fi/WiMax wireless technology, to play a key role in distribution of gigabit consumer broadband services over the last mile, last few hundred meters

Recommendation GE mobile/Wi-Fi targets

Given that the GE digital connectivity strategy is intended to be forward looking, over the next, 10, 20 to 30 years, and to underpin digital connectivity objectives in the GESp, we recommend that GE focusses on 5G development and its commercial deployment, integrated with Wi-Fi/WiMAX wireless technology. There are no specific targets to set at this stage – it's too early to do so, instead, we recommend that GE initially focusses on securing funding for local pilots to help further develop and test-bed 5G and associated wireless technology, with the aim of then putting in place a full mix of local measures designed to support and enable rapid full scale commercial investment in the next decade

Mapping current availability of consumer broadband and mobile service availability

Fixed line

- 2.15 With reference to Ofcom's three consumer broadband service definitions (standard, super-fast and ultra-fast broadband)
- GE has virtually no ultra-fast (gigabit-capable) consumer broadband connectivity, neither does much of the rest of the UK, with the exception of those cities that are benefiting from BT's focussed FttH roll-outs and from joint ventures with the new breed of altnets which are starting to deploy gigabit-capable infrastructure across parts the city
 - GE is however reasonably well served by super-fast (also termed NGA) consumer broadband, but gaps remain. At the top end of the super-fast spectrum a third of households and 16% of businesses can access download speeds of 100 Mbps or more. Taking 30 Mbps as the lower end of the NGA speed benchmark, 86% of households and 67% of businesses can access downloads speeds of 30 Mbps or more
 - But this also means that 14% of households and 33% of business premises still cannot access 30 Mbps download speeds in GE
 - 10 Mbps is today regarded as the minimum acceptable download speed and will be the threshold set by the new broadband USO under discussion in parliament. Just under 10% of households and business premises in GE cannot access 10 Mbps (this is nearer 20% for Mid Devon)

Figure 2.1: Download speed availability – households and business premises – across GE

100 Mbps download speed target

- 35% of households are in areas that offer download speeds of 100 Mbps or more
- 16% of businesses are in areas that offer download speeds of 100 Mbps or more

30 Mbps download speed target

- 86% of households are in areas that offer download speeds of 30 Mbps or more (this also means that 14% of households cannot access 30 Mbps download speeds)
- 67% of businesses are in areas that offer download speeds of 30 Mbps or more (this also means that 33% of business premises cannot access 30 Mbps download speeds)

Business connectivity – by type of premises – less than 30 Mbps download speed

- 38% of factory business premises are in areas offering less than 30 Mbps download speed
- 35% of warehouse business premises are in areas offering less than 30 Mbps download speed
- 34% of office business premises are in areas offering less than 30 Mbps download speed
- 30% of retail business premises are in areas offering less than 30 Mbps download speed

10 Mbps download speed target

- 9% of households cannot access 10 Mbps (this is nearer to 20% for Mid Devon)
- 9% of business premises are in areas offering download speeds of less than 10 Mbps (this is nearer 20% for Mid Devon)

Source: Point Topic mapping data and Adroit Economics Analysis

Mobile coverage

- 2.16 4G coverage and gaps - mapping of 4G coverage, and hence of 4G coverage gaps in GE, at a sufficiently granular level to be meaningful is not yet possible, because MNOs⁴ are not prepared to release their data because of commercial sensitivity reasons. Ofcom is seeking to address this at present, but at the time of writing, it is unclear to what extent and when this will be achieved
- 2.17 CDS states that there are 7,000 households in Devon and Somerset with no outdoor 4G coverage; this will translate into a higher number still of premises with no indoor coverage; and a proportion of those with coverage may only be served by a single Mobile Network Operator (MNO), but will still show as having outdoor coverage on Ofcom's maps - so there will be many more consumers whose network does not serve both their home and work address, for instance
- 2.18 5G coverage and gaps - 5G technology is still not finalised. The Government's 5G strategy anticipates deployment to commence early in the next decade. The Government's strategy identifies 5G as a transformational technology, with use-cases and impacts way beyond the way 4G is currently used. 5G will provide very fast higher quality connectivity to smart phones/ tablets etc, but it is also expected to be embedded in and utilised in smart city and industrial applications

Likely future investment in consumer broadband network and mobile services

- 2.19 We expect there to be significant investment in, and deployment of, additional network infrastructure addressing gaps and growing demand across all three types of broadband (Ofcom's definition) nationally and in the Southwest (including in the GESP area):
- **standard broadband:** (download speeds of up to 30 Mbit/s) – tail end and additional CDS programmes; introduction of a 10 Mbps standard USO; ad hoc community initiatives (including in partnership with the incumbents)
 - **superfast broadband:** (download speeds from 30 Mbit/s up to 300 Mbit/s) – BT's rollout of G-Fast, Virgin Media rollout
 - **ultrafast broadband:** (download speeds of 300 Mbit/s moving towards Gigabit connectivity) – BT's G-Fast and FttP programmes; Virgin's Lightning Speed programme; investment by one or more altnets (City Fibre et al). Currently Greater Exeter has limited investment by three altnets - Gigaclear, IFNL and CityFibre/third party network are in Exeter and East Devon (via an earlier purchase of kcom network).
- 2.20 Drivers of future consumer broadband investment and rollout will be
- Significant change in national policy, refocussing from gap funding super-fast to pump priming ultra-fast (particularly local full fibre networks)
 - Further changes to the regulatory environment making it easier for other service providers to invest in new infrastructure alongside BT and Virgin and to share the incumbents' infrastructure
 - Rapid emergence and growth of a cluster of increasingly well-funded new entrants often termed the altnets
 - New sources of funding for digital infrastructure from the capital markets which now see investment in infrastructure as a safe long-term play rather than a risky short-term bet
- 2.21 However, we anticipate that major gaps at all three service levels will remain, requiring and justifying a pro-active local GE digital connectivity strategy, that implements best practice interventions and that

⁴ Mobile network operators

optimises Government, National Infrastructure Commission and institutional funding as it becomes available

- **Regarding basic broadband** - it is not clear to what extent, how quickly and how effectively the 10 Mbps USO proposals will be implemented
- **Regarding superfast** – CDS Phase 1 delivery has achieved its targets, delivering in excess of a quarter of a million superfast connections across the CDS area. Phase 2 is now underway and will be delivering ultrafast FttP to thousands more premises including within the GESP area. We recommend that GESP partners continue to monitor both commercial investment and public intervention in FTTP to ensure that duplication is kept to a minimum, that public funding prioritises hard to reach businesses and communities and that digital connectivity forms part of planning for new developments and infrastructure of all kinds

The latest CDS monitoring reports show:

- 43% of premises passed by CDS-funded upgrades have taken up superfast connections.
- This level of take up is in line with national average (42.1%) and has generated confirmed gainshare of £4.8m across the CDS area – with potential for a further £2m, dependent on a review of take-up in Phase 1.
- CDS plans a bid to DEFRA for an additional £5m of Rural Broadband Infrastructure funding, which if successful would be used to top up existing contracts with Airband (although this would not serve the GESP area) and Gigaclear.

- **Regarding ultra-fast** – although this is the new national policy mantra, all acknowledge that extensive investment in local access fibre network is a massive job which will take time; moreover, the policy approach remains similar to the superfast approach, hence it is reasonable to assume that significant gaps/disparities/ connectivity inequality will remain a feature of Britain's digital connectivity landscape.

Conclusions – future gaps in consumer broadband services in GE

The key messages to draw from this are:

- Whilst the two incumbents, BT (Open Reach) and Virgin Media, are undertaking major investment programmes, it is not clear how fast and to what extent a broadband USO service will be ensured across GE.
- Neither is it clear to what extent current remaining NGA gaps will be filled or to what extent and how quickly ultra-fast services will become available, through investment in local full fibre networks and services

Addressing the remaining unserved premises

- By 2020, there will still be 14,400 premises in the GESP area without access to superfast connections.
- Commercial investment is slowing: known plans for commercial investment across the four local authorities represent only 2,500 of the 14,000 new connections expected across the CDS area by 2020.
- CDS will be releasing an additional 1,800 vouchers for residents and businesses, but this is for whole CDS area; the total allocation represents only 12.5% of remaining unserved premises in the four GESP local authorities.
- It is clear that current rates of commercial investment and public intervention will still leave superfast coverage in the GESP area below the national average.

- This provides the justification for a pro-active GE digital strategy which would bring forward investment more quickly, particularly in areas that might be considered less attractive for commercial investment, and to accelerate delivery of world class digital connectivity that might encourage inward investment and jobs growth
- Given the forward-looking nature of the GE digital strategy, we recommend that it focusses on putting in place a comprehensive package of local measures designed to support and enable increased investment in local full fibre network via a variety of providers, with the aim of stimulating investment, competition and innovation across all elements of the digital connectivity supply chain

Demand for future digital connectivity across GESP

- 2.22 Basing GE digital connectivity targets on national targets is one approach. It is also important to look at current and likely future demand/need by GE SMEs and households, as a secondary and equal method of defining future GE connectivity targets
- 2.23 We have reviewed/used five sources of evidence/methods to provide a picture of future demand

Original DCMS Exeter voucher scheme - take-up

- 96 vouchers were applied for and 69 were completed
- Average download speeds increased by 17 times (BT), 4 times (Talk Talk), and 18 times (Zen). Virgin original speed data was redacted
- Average upload speeds increased by 204 times (BT), 31 times (Talk Talk), and 72 times (Zen). Virgin original speed data was redacted

Original DCMS Exeter voucher scheme – latent demand

- The scheme manager reports that a number of applications involved substantial extra-over costs, above the scheme threshold – these SMEs presumably still want a better service
- The scheme manager also reported that a number of applications were made after the closure of the scheme

GE SME broadband survey

- Most respondents (77%) were unhappy with the current level of service
- Most respondents still not receiving superfast levels of service - 80% were receiving average download speeds of less than 30Mbps; more than 93% had services where the average upload speed was less than 30 Mbps⁵
- Business-grade services, as well as ‘speeds’, are a priority – respondents, in order of priority wanted (i) quality and stability of connection (ii) faster downloads (iii) faster uploads
- Broadband connectivity is identified as the most important factor in determining future business location (with mobile service connectivity a close second), above proximity to roads, rail, airports; and above access to a skilled workforce

⁵ Please note that, without further analysis, we do not necessarily know whether these respondents could access a superfast service and had not upgraded their connection. It should also be noted that those able to access superfast wouldn't necessarily be inclined to respond

- Respondents anticipated greater productivity and innovation – resulting in an average sales increase of 20% and a similar gain in productivity (derived largely from staff time saving)

Modelling theoretical future connectivity needs of GE SMEs and households

- 2.24 The Broadband Stake Holder group (BSG) had two major modelling studies undertaken, one estimating the future download and upload speeds of different types and sizes of business, the other estimating the future download and upload speeds of different types and sizes of households⁶. The models estimated future bandwidth needs by 2023 (for households) and by 2025 (for SMEs). Both models were based on detailed bottom-up analysis, comprising
- 2.25 We have used the core calculations in both models to estimate likely future peak bandwidth needs of SMEs and residents in GE by 2023/25, and then used the results to estimate total bandwidth needs required to support a typical new settlement in GE (see further on for this later analysis).
- 2.26 For GE SMEs, we estimate that:
- An employee in a low-media user firm is estimated to require 44/39 Mbps download/upload capacity at peak (assuming they are undertaking all online types of activity all at once)
 - An employee in a high media user firm is estimated to require 54/44 Mbps download/upload capacity at peak.
- 2.27 Bandwidth needs per firm are then calculated by multiplying employee bandwidth need by number of employees – we have modelled four sizes of SME comprising 3, 5, 10 and 25 employees
- For a semi media using SME, we estimate that five-person office will require 184 Mbps down and 156 Mbps up at 75% of peak
- 2.28 For GE households, we estimate that:
- A 2-bed household is estimated to need 19/8 Mbps download/upload by 2023 to support 75% of peak activity i.e. occupants are undertaking 75% of all possible online activities at once
 - A 4-bed household is estimated to need 24/10 Mbps download/upload by 2023 to support 75% of peak activity

Conclusions/recommendations – evidence from GE of future bandwidth needs

- There is significant dissatisfaction from a number of SMEs regarding current consumer broadband service availability; a proportion have solved their problems through the original voucher scheme, but dissatisfaction remains - a number of voucher applicants were excluded from the scheme because they were subject to high connection costs and a number of applications were received for vouchers after the scheme's closing date, suggesting that demand remains for faster better broadband.
- The GE SME broadband survey reflects this dissatisfaction indicating that a number of SMEs want faster more reliable connections and that they anticipate that significant financial and economic benefits will derive from faster better broadband, in terms of increased sales and productivity gains (mainly derived from staff time saving).
- Theoretical modelling of future SME and household bandwidth needs suggests that by 2025, a medium media intensive SME employing 5 will need 184/156 Mbps download/upload capacity to meet 75% peak activity. These

⁶ BSG (The Broadband Stakeholder Group) commissioned creation of two detailed bandwidth use/demand models, one for business premises and one for households. The models are available to members. Point Topic, a member of the Adroit Consortium gained access to the models. Both models are constructed to enable estimating of total national bandwidth needs. We have drawn on key input data/ assumptions in both models to create an alternative model, designed to estimate bandwidth needs for individual households, by size (occupancy) and for individual business units, by type (office, logistics, factory, retail) and by size (employment)

speeds and the quality of service required will, in many cases be better met through provision of business grade services, rather than via standard consumer broadband.

- Theoretical modelling of future household bandwidth needs suggests that by 2023, a 2-bed household will need 19/8 Mbps download/upload by 2023 to support 75% of peak activity and a 4-bed household will need 38 Mbps. The figure rises to 50 Mbps to support 100% of peak.

Conclusions

- Our local demand analysis inevitably is limited and only looks ahead as far as 2023/25. The GE digital strategy is intended to take a longer-term view.
- Our SME demand analysis suggests that a proportion of SMEs need faster better broadband services now, and that by 2025 SMEs will need considerably faster near symmetric services than are currently available via consumer broadband. Moreover, many will also need better-quality services than are currently available via consumer broadband. This suggests that the Government's current focus on increasing investment in local full fibre networks will be highly beneficial to GE SMEs. And, although most do not yet need gigabit level services, demand is fast moving towards this
- Our household analysis suggests that many households' bandwidth needs will continue to be met by super-fast consumer broadband services. Our analysis only looks as far forward as 2023 though. Looking further ahead, given the long-term evidence of exponential growth in bandwidth demand, coupled with circumstantial evidence (such as the recent announcement from Sky TV that they intend to migrate delivery of TV services from satellite to wholly broadband), it is likely that GE households' needs will increasingly require ultrafast consumer broadband services. This suggests that the Government's current focus on increasing investment in local full fibre networks will be highly beneficial to GE households. And, although most do not yet need gigabit level services, even for those households supporting increased homeworking, demand is fast moving towards this.

Mobile coverage, issues and next steps - GESp

4G coverage and gaps

- 2.29 Mapping of 4G coverage, and hence of 4G coverage gaps in GE, at a sufficiently granular level to be meaningful is not yet possible, because MNOs⁷ are not prepared to release their data because of commercial sensitivity reasons. Ofcom is seeking to address this at present, but at the time of writing, it is unclear to what extent and when this will be achieved
- 2.30 CDS states that there are 7,000 households in Devon and Somerset with no outdoor 4G coverage; this will translate into a higher number still of premises with no indoor coverage; and a proportion of those with coverage may only be served by a single Mobile Network Operator (MNO), but will still show as having outdoor coverage on Ofcom's maps - so there will be many more consumers whose network does not serve both their home and work address, for instance

5G coverage and gaps

- 2.31 5G technology is still not finalised. The Government's 5G strategy anticipates deployment to commence early in the next decade.
- 2.32 The Government's strategy identifies 5G as a transformational technology, with use-cases and impacts way beyond the way 4G is currently used. 5G will provide very fast higher quality connectivity to smart phones/ tablets etc, but it is also expected to be embedded in and utilised in smart city and industrial applications

⁷ Mobile network operators

- 2.33 Key activities at the moment include funding of local pilots – we understand that GE has not applied to any of the current funding rounds
- 2.34 Successful rollout of 5G is anticipated to require a larger volume of masts, dishes, antenna etc, hence GE will need to ensure that the local planning regime is ready for this
- 2.35 Successful rollout of 5G is also anticipated to require high capacity backhaul, mainly provided by fibre optic cable. Hence, successful rollout of 5G will require extensive local access fibre network. Thus, 5G rollout will depend in part on how successful GE's Local Full Fibre Network programme of investment is. This is likely to be particularly challenging in rural areas.

Conclusions/ recommendations – 4G/5G - actions for GE to consider undertaking

Addressing current 4G coverage gaps, particularly in the rural areas

We identify 4 potential action areas to consider in discussion/ consultation with the MNOs⁸. None of these are currently straightforward and success is likely to be limited in the short term at least

- Mapping 4G coverage gaps at a sufficiently granular level to be useful – including overlaying with land use maps, public land ownership maps. This depends on how fast Ofcom can get MNOs to share network data
- Further reduction of land use planning obstacles to installation of new masts/towers – GE should explore this now
- Gap funding MNO network rollout – currently prevented by EC State aid regulations, so it's a case of waiting to see if these regulations continue to apply post-Brexit. The current thinking is that they are likely to
- Community action – investment by households and businesses in mobile phone signal repeaters. This is a low-cost way of extending the 4G network. It is subject to regulation however. Ofcom has just completed a review of the regulation and decided to permit use of repeaters by households only, but only within the house, not between properties. So, at present, this option is not available

Preparing the way for 5G deployment, anticipated to take place in the next decade

We identify a two stage 5G strategy for GE

- Taking an active flagship role in helping develop 5G technology and its applications
- Paving the way for 5G rollout, by making GE more investment ready for 5G

Stage 1: Taking an active flagship role in helping develop 5G technology and its applications

- Government and intermediary agencies have issued a number of competitive funding rounds focussed on pilot programmes. GE as far as we are aware has not bid into any of these as yet. It should seek to do so in the next available funding rounds.
- Examples of the types of pilot/demonstrator studies that GE could seek to pursue include:
 - 5G and smart settlements - focussing on development proposals which arise through the GESP
 - 5G and one or several industry-sector applications
 - 5G and precision agriculture

Stage 2: Taking an active flagship role in helping develop 5G technology and its applications

- Planning - GESP needs to address potential planning hurdles to masts/dish sites - Planning regulations are a key factor influencing a network infrastructure provider's ability to expand its network, as they govern where sites can be built and the physical appearance of the equipment that can be installed on such sites. The deployment of 5G will require a significant increase in the number of small radio cells - likely to be located on street furniture, the

⁸ Mobile network operators

sides of buildings etc. - in order to facilitate the requirements of 5G networks. Therefore, flexible and fit for purpose planning regulations will be required to support the deployment of 5G networks.

- Fibre backhaul - actively implement all feasible measures possible to support and enable large scale investment in local full fibre networks across GESP, including in the rural areas

Public wireless projects - Wi-Fi/WiMax⁹

Defining what we mean by public Wi-Fi

- 2.36 Wi-Fi services/access, for the purposes of this study, are usefully divided into two types:
- Wi-Fi available in your house or office, via the wireless router in your bedroom or office. The backhaul for the Wi-Fi is the 'fixed-line' service to your router. We might term this 'private Wi-Fi', which is password protected and can be regarded as an extension of your fixed line service.
 - Wi-Fi available in the public realm, in public buildings, in visitor destinations. Although these services will require a fixed line back haul, they are conceptually different from home or office Wi-Fi, in that they are intended for public (mobile) use
- 2.37 Wi-Fi targets in strategies tend to focus on the latter rather than the former

Wi-Fi targets

- 2.38 Some strategies also seek to promote Wi-Fi targets in addition to mobile targets, most commonly in relation to availability of free or charged for Wi-Fi services in certain parts of the public realm, in public buildings and in some cases in visitor establishments such as cafes etc. Targets are set in terms of availability, cost and speed.
- 2.39 Alternatively, Wi-Fi availability is not set as an overall target but instead is treated on a project by project basis.

Issues/difficulties with public Wi-Fi projects

- 2.40 Many Wi-Fi projects however run into difficulty in a number of areas:
- Determining rights to access to public assets – e.g., lighting poles, street furniture, and public buildings – on which to mount transmitters and repeaters. Some 'public' assets are actually owned and maintained by third parties, and this can increase costs, complexity and contractual conflicts over their use for this purpose.
 - Growing competition between mobile services and Wi-Fi services. Wi-Fi tends to be free or much lower cost per unit than mobile services and of recent a growing plethora of apps enable voice and video calls to be made over Wi-Fi, thus increasing direct competition with the mobile market.
 - This competition between commercial mobile and public Wi-Fi services extends to access rights to locate transmitters and repeaters on public buildings – where mobile network operators may be willing to pay a premium for exclusivity

⁹ WiMAX (Worldwide Interoperability for Microwave Access) is a family of wireless communication standards based on the IEEE 802.16 set of standards, which provide multiple physical layer (PHY) and Media Access Control (MAC) options. The name "WiMAX" was created by the WiMAX Forum, which was formed in June 2001 to promote conformity and interoperability of the standard, including the definition of predefined system profiles for commercial vendors. The forum describes WiMAX as "a standards-based technology enabling the delivery of last mile wireless broadband access as an alternative to cable and DSL".

- Increasing competition with mobile operators increases State aid/competition issues regarding Wi-Fi projects

2.41 This suggests the need for carefully focussed/ targeted public Wi-Fi/WiMax projects

Conclusions/ recommendations – Wireless (Wi-Fi/WiMax)

We recommend that there are three key potential roles for public realm/public building Wi-Fi/WiMax projects

- Free Wi-Fi in public buildings and public realm
- Exploring how to use public Wi-Fi projects to address/ compensate for gaps in 4G coverage
- Exploring how to integrate Wi-Fi/WiMax technologies with 5G

GE rural connectivity issues

2.42 We think it is important to have a separate section looking at rural connectivity issues in GE in particular. This does not mean that the urban areas do not face connectivity issues. It does mean that the degree of issue faced in rural areas is greater. This is principally because the more dispersed nature of businesses and households increases the unit cost of digital connectivity infrastructure considerably. This makes it harder for the incumbents and indeed, the altnets to make a business case for investment of network rollout, which means that without intervention, rural areas will either be left behind or will be last in the queue.

2.43 The types of technology and the policy solutions are common between both rural and urban areas, but the cost (and unit) cost of intervention in the rural areas will be greater.

2.44 These dynamics also mean that policy makers face a dilemma when targeting scarce grant and other public resource at rural connectivity issues:

- The economic impact and economic return on investment is likely to be higher for urban rather than rural projects
- Therefore, do policy makers decide to focus budgets on urban areas, or rural areas, or split the effort equally.

2.45 Above all, the cost of solving the rural issue will be large and may be impossible, even with innovative policy solutions and a more generous grant regime than hitherto seen recently.

Particular challenges prevalent in GE's rural areas

2.46 Rural connectivity issues include:

- Remaining super-fast (NGA gaps)
- Uncertainty over the effectiveness and timing of rollout of a national 10 Mbps Universal Service Obligation for broadband,
- Significant gaps in mobile coverage (4G),
- Lack of clarity over what form 5G will take and need for substantial fibre backhaul

Focus for GE's rural connectivity policy

2.47 This would suggest that the main policy priority for GE's rural areas is to explore measures that will ensure wide deployment of local fibre networks. This will provide the necessary backhaul for 5G, it will help address any remaining superfast gaps...and...it will help ensure that rural areas are not left out as the urban areas pursue local full fibre network deployment.

Major investment will be required, which is unlikely to be viable without support

- 2.48 Major investment will be required – which by the usual rules will not be deemed ‘cost effective to commercial operators. The ‘traditional business models’ of the incumbents (and even of the newly emerging altnets) which are urban focussed, are unlikely to work – investing in deep fibre in rural areas will be deemed not cost effective.
- 2.49 This suggests that the market’s traditional (and new) approaches, even with substantial Government gap funding, are unlikely to work fully or at all; this suggests that alternative, more radical, business models need to be considered. This is only likely to happen if the local authorities and local communities take pro-active action to do this.

Conclusions/ recommendations – GE’s rural connectivity issues

- From this we conclude that there is a case for a rural theme in the GE digital connectivity strategy, either as stand-alone or as a continuation of urban themes in the strategy - no matter how much funding might be available from central government and/or the incumbents and altnets for investment in local fibre networks in rural areas, it is very likely to fall short of the total required. Without ‘more radical initiatives at the local level’, a similar pattern to previous rural deployments seems likely, namely patch-work, uneven and delayed deployments with a proportion being left out.
- **Time for more radical models** - for these reasons and given that Government for the first time is suggesting that local authorities and local communities play a much more prominent, if not lead role, in initiating and funding local fibre deployments, we see the time being right to explore new, alternative local fibre funding, ownership and operational models, perhaps replicating earlier successful projects such as Cybermoor/B4RN or at least drawing on these.
- Certain project themes being promoted by DCMS’s current Local Full Fibre Programme competition would seem to be particularly pertinent. For example, the GE digital connectivity strategy could promote a public-private-community based fibre investment, build and manage vehicle, that leverages existing public- sector connectivity spend, any publicly owned networks, LFFN grant and institutional investment funding, enabled by the National Infrastructure Commission’s fund managers (e.g. Amber)
- There would be trade-offs for such a project – funding new dig in rural areas, with the consequent higher unit costs, would mean there is less funding available for urban areas, but an urban-rural model will enable cross subsidy to be explored.
- The options are complex and need to be considered by stakeholders; a project team will need to be assembled (comprising local authority officers, other stakeholder organisations and with specialist consultancy support), a business model and options appraisal will need to be prepared/undertaken, as part of the LFFN bidding process. The amount of work involved for just the urban element is substantial; including the rural element will increase the level of preparatory work required significantly. The time required to prepare a business case and options appraisal, including time for consultation and discussion is in our view at least 3 months

New settlement bandwidth capacity requirement modelling

- 2.50 We have modelled the bandwidth capacity required to support an illustrative new GE settlement comprising 10,000 houses and just under 1,000 business.
- 2.51 We have done this using a model first developed for the London Borough of Haringey, to model the connectivity needs of major proposals to redevelop the Borough’s two key transport hubs, Woodgreen and Tottenham Hale adapted to suit a more rural location.
- 2.52 The specification of the illustrative GE scheme was provided to us by the GESP team. Whilst at this stage the GESP development strategy has not yet reached such maturity as to know whether there will be any new settlements proposed as part of it, clearly this could be an option. Such a development could potentially have quite different digital connectivity issues, requirements and solutions than expansions to existing settlements, and as such it is prudent to consider these in determining what the correct

strategy for GESP should be. The scale of the illustrative example scheme was decided as an easily scalable figure, large enough to deliver a range of different digital needs and uses within it which could therefore test a range of assumptions. The scheme is purely indicative and does not necessarily represent the scale or mix of uses that the GESP or Councils in general might ultimately deem acceptable. The illustrative scheme comprises:

- 10,000 new homes
- B1, B2 and B8 employment space accommodating circa 915 business units, employing circa 7,000 people
- Retail space accommodating circa 40 business units employing 250 people

2.53 We have modelled the download and upload capacity requirements for the following types of uses

- Fixed line connectivity
 - = To households – bandwidth needs are based on those reported in the previous section derived from the BSG model
 - = To business premises - bandwidth needs are based on those reported in the previous section derived from the BSG model
- Mobile (5G) /public realm wireless - bandwidth metrics are based on those used in the London Borough of Haringey model
 - = To residents when in their homes - a proportion will still use mobile services in addition to fixed line (inbuilding WiFi) services
 - = To employees when in their place of work – a proportion will still use mobile services in addition to fixed line (inbuilding WiFi) services
 - = To those travelling – on foot, by car, bus, taxi – 5G services
- Smart city/ smart settlement functionality – digital connectivity needs - bandwidth metrics are based on those used in the LBH model
 - = Guided/ assisted vehicles + road transport monitoring and management
 - = IoT¹⁰ - household appliances, household systems (heating, lighting, power, monitoring, security); business premises appliances, business premises systems (heating, lighting, power, monitoring, security – integrated in building information management platforms (BIM))

Conclusions/ recommendations – bandwidth requirements of an illustrative new settlement and suggested network architecture

Total bandwidth capacity requirement

Total bandwidth capacity requirement of an illustrative new GE settlement comprising 10,000 houses and just under 1,000 businesses, to support 75% of theoretical peak is

- Download – 1.7 Tbps
- Upload – 1.6 Tbps

¹⁰ Internet of Things

Suggested network technologies

Three key features are required:

- Capacity (scalable) which suggests fibre optic cable
- Reliability (resilience) – both physical (e.g. more than one feed so that if a JCB accidentally cuts through one feed, traffic is automatically re-routed; and commercial (e.g. avoiding reliance on one commercial supplier at all levels of the supply chain)
- Competition which stimulates innovation, choice and value for money to the customer – which suggests an open access backhaul, settlement ring/spine, and local access network operation, including on-site/in building. Open access operation is where the owner/operator of the physical duct, allows any and all suppliers to pull/blow their own fibre through the duct; which allows any and all suppliers competitive access to the fibre (either dark or lit); which allows any and all suppliers competitive access to the ethernet service delivered over the lit duct. This ensures competition and choice at each and every level of the digital connectivity supply chain (duct, dark fibre, lit fibre)

Suggested physical architecture

Network resilience is key - because at least half the bandwidth capacity required by the settlement is to support assisted driving¹¹, the network needs to offer the highest possible resilience (reliability). We suggest therefore that a similar network architecture is used to those used for other locations that require very high reliability – namely data centres. Data centre network architecture can also be found used in other locations e.g. science parks, business parks. Key features of the architecture are as follows:

- Fibre optic cable throughout – external links (backhaul), settlement rings/spine network and local access network
- Two physically separate feeds to the settlement from two physically separate PoPs
- Connecting the settlement at two completed different physical connection points¹²
- Linking into a settlement ring (or rings), off of which local access links are run to connect clusters of buildings

¹¹ See appendix S for further information on assisted/autonomous vehicle connectivity requirements

¹² This ensures dual physical connections from (a) the network and (b) at the site

3. Executive Summary – proposed GE digital connectivity strategy

Rationale for a GE digital connectivity strategy

- 3.1 Usually, there is only a need for public sector intervention if there is an issue or problems to address. In this case, there are issues and problems that need addressing through appropriate public-sector intervention – thus justifying a GE digital connectivity strategy.
- 3.2 The fixed-line consumer broadband issues are (with reference to Ofcom’s three consumer broadband service definitions (standard, super-fast and ultra-fast broadband)):
- Significant gaps in super-fast in the rural areas, with some knot-spots in the urban areas
 - Some of these gaps do not even deliver the proposed USO minimum of ‘standard broadband’
 - Almost no ultra-fast
- 3.3 Mobile 4G/5G issues are:
- Gaps in 4G in the rural areas
 - Need to pave the way for 5G so that GE is not left out when it becomes a viable technology

The objective of the GE/GESP digital connectivity strategy

- 3.4 Addressing some of these issues is playing ‘catch-up’. The GE digital strategy is however intended to be forward looking, to identify and put measures in place to help deliver future connectivity needs and infrastructure.

Hence, whilst it is important to remain cognisant of current issues, and to ensure these are addressed, the over-arching objective of the GE digital connectivity strategy is to look to future needs and opportunities

- 3.5 The objective of the GE/ GESP digital connectivity strategy is to set out a strategy and supporting measures that are forward-looking; that will support, encourage and assist a competitive telecoms industry to invest in telecoms network infrastructure and services that will meet the demands/needs of local businesses, households and public services in the future (10, 15 20 years ahead or more), across all of the city-region, including the rural parts; that will support and drive adoption of ‘smart-city’, ‘smart-neighbourhood’ technologies and practices; that will underpin the transformation of the city-region economy from one of over-reliance on traditional industry and business sectors to growth of new, high value, technology and knowledge-based industries, that will generate high value jobs and career opportunities and that will drive advanced skills training, innovation and enterprise.
- 3.6 The GE digital connectivity strategy will provide the framework and justification for inclusion of specific measures in the GESP, a new forward-looking city-region strategic plan. Strategic and local land use planning policy can play an important role in communicating the importance of digital connectivity, in promoting advice on good practice, and, where necessary, in helping drive investment in appropriate digital infrastructure, particularly with respect to new settlements and brownfield re-development.

Focus on productivity and infrastructure investment paves the way for a forward-looking GE/GESP digital strategy

- 3.7 The Autumn Statement 2016¹³ marked a shift in Government policy to focus on productivity. Brexit has heightened concerns that the UK is falling behind competitors; investment in 'full fibre' digital infrastructure is identified as a key measure to address this.
- 3.8 The result is a strategy that focuses on ways in which public bodies can aggregate their own contracts and infrastructure to leverage more private investment from communications providers, including emerging 'alt nets.' This reflects the fact that the investment needed to deliver full fibre is far beyond the scope of public intervention, particularly in a straitened fiscal climate.
- 3.9 Whilst there is funding available through the National Productivity Investment Fund, this shift in strategy is most significant in providing powerful support, a framework and guidance, for a forward-looking GE digital connectivity strategy
- 3.10 The shift in policy is marked in the Digital Economy Act (2017) and subsequent DCMS announcements that move the focus of intervention from gap-funding aimed at improving services on existing hybrid fibre-copper networks (typified by the rollout of super-fast broadband (NGA), mainly through gap funding the incumbent (BT) to extend fibre deeper into its legacy copper telephone network, particularly in rural areas), to one of a focus on pilot-funding deployment of local full fibre networks, in both urban and rural areas. The Local Full Fibre Networks (LFFN) programme, launched in Nov 2017, offered local authorities the opportunity to bid for a share of a £200m competitive fund through (at least) three bidding rounds.
- 3.11 The new policy and LFFN programme emphasises boosting competition in fibre network investment at the local level, through encouraging local authorities to engage with the new breed of fast growing 'new entrants' (termed alt nets), some of which (e.g., City Fibre) are named in the programme guidance. This is part of a strategy to increase the range and value of private investment in digital communications infrastructure; and a low risk way for Government to test the scalability of those business models.
- 3.12 The new policy and LFFN programme also mark a shift in policy through an emphasis on new intervention models indicating that local authorities, previously discouraged from directly investing in, or part owning telecoms networks, should now consider doing so through one or more of several suggested methods, citing (for example) the Thin Layer Model implemented by Tameside in Greater Manchester.

The over-arching objective of the GE digital connectivity strategy

- 3.13 Reflecting new Government policy and its focus on investment in extensive local full fibre networks, the long term over-arching objective of the GE digital connectivity strategy must be one of promoting, supporting and enabling increased investment in local access fibre networks, by as broad a mix of telecoms companies – incumbents and the new alt nets – through a variety of mechanisms and business models, in order to optimise not just levels of investment in local fibre network but to maximise competition and choice. National policy identifies effective competition in the telecoms/broadband industry as essential to the provision of high quality, reliable, competitive connectivity services to businesses, households and public services. This means opening up the incumbent's network to competitors through regulation (Ofcom); and it means promoting parallel network investment, ideally operated on a similar open-access basis.

¹³ HM Treasury (2016). Autumn Statement, published November 2016.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/571559/autumn_statement_2016_web.pdf

There are four things that local authorities can now do to support and drive local full fibre network investment

- 3.14 There are four things that local authorities can now do to support and drive local full fibre network investment – and these will form the four themes of the GE digital connectivity strategy

Making the area as investment-ready as possible	Supporting and driving investment in local full fibre networks
Theme 1 On-site – new settlements, brownfield developments (business and residential) and all other developments above a minimum threshold are encouraged/ required (by planning) to install fibre optic duct alongside other utilities/services, at the design and build stage¹⁴. This will make it easier, reduce the costs and increase the likelihood of telecoms service providers installing network and offering services to occupiers once the scheme is complete. This will open up choice and stimulate competition	Theme 3 Demand-side – a voucher scheme, offering subsidy to customers (SMEs, households) to pay for extra-over connection costs. The LFFN programme proposes a giga-bit capable voucher scheme, ensuring that only network capable of supporting giga-bit connectivity (e.g. fibre) is funded
Theme 2 Public realm – administrative and regulatory costs, delays, difficulties (street works, highways and planning) are minimised to telecoms investors when digging duct, laying cable, sighting masts, dishes and antenna; promoting use of a standardised way leave template will also help reduce deployment costs	Theme 4 Supply-side – new local authority/ community investment and business models, reflecting guidance in the LFFN programme – for example, leverage publicly owned network, sites and premises, coupled with current annual connectivity spend, to attract external investment in local full fibre network

- 3.15 There are other things that local authorities can do, but the above four themes form the mainstay of any local full fibre digital strategy. Other measures we suggested are considered under two additional themes

Theme 5 Supportive/ cross-cutting actions – for example establishing one or more local Digital Exchanges; aligning strategically with other initiatives and developments so far as possible; formulating an effective digital skills strategy	Theme 6 Future technologies, future applications – such as exploring the role of and need for digital connectivity to support the functions of smart cities/ smart settlements, and how this applies to those developments being proposed by the GESP for GE; piloting and development of 5G technologies, paving the way for early adoption in GE and exploring the digital connectivity requirements of agriculture and opportunities for GE to become earlier adopters
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¹⁴ Installing duct alongside installation of other utilities is much lower cost than installing duct on its own, as the dig costs can be shared/apportioned

To conclude

- 3.16 We suggest that the GE digital connectivity strategy comprises 6 principal themes under three broad headings
- Making the area as investable as possible - for those seeking to invest in rollout of local full fibre access networks
 - = Using planning policy and digital accreditation to ensure new developments are fibre-ready
 - = Streamlining/standardising highways and planning to reduce cost, delays and uncertainty to telecoms companies laying new fibre
 - = Promoting use of a standardised way leave template
 - Supporting and driving investment in local full fibre networks
 - = Customer (demand-side) subsidy - e.g. a gigabit-capable voucher scheme - the UK's most recent voucher scheme enabled SMEs to increase productivity and sales resulting in net additional economic benefits of circa 30% per SME on average
 - = Direct/shared investment by public sector in local full fibre network, via one of several models e.g. the Aggregation Model, the Thin Layer model, the Dig Once Trust, designed to offer an alternative to, and stimulate competition amongst the incumbents
 - Supplementary actions
 - = Cross-cutting initiatives such as establishing a local digital exchange; establishing/strengthening local digital skills (both user and professional skills) alongside wider regional and national initiatives so much as possible.
 - = Exploring development and adoption of future technologies e.g. digital connectivity requirements for smart cities/smart settlements; pilots and accelerate rollout of 5G

Cost and funding

- 3.17 Most of the actions are minimal cost e.g. require mainly staff time and some specialist advice
- Incorporating appropriate digital infrastructure policy in local planning policy (via the local plan and SPG) will only involve staff time with the possibility of additional specialist consultancy support
 - Streamlining highways, planning etc can be undertaken internally
 - Establishing/strengthening digital skills in the city region can be driven through main stream budgets and collaboration with private sector e.g. Microsoft et al
 - Exploring future technologies, such as establishing local pilots, can be done through selective grant funding e.g. there have been three rounds of funding for 5G pilots, there will be more
- 3.18 Those actions that involve significant capital cost e.g. the voucher scheme and direct/shared investment by local authorities in full fibre networks, will involve substantial investment. The suggested approach to this is as follows
- Voucher scheme
 - = This should be grant funded. The next grant funding opportunity is round 3 of the LFFN programme; there will almost certainly be subsequent funding opportunities after this, given the success and cost effectiveness of the original national scheme

- Direct/shared investment by local authorities in rollout of local full fibre access network
 - = This is the most contentious action. It is only on the table because Government is now offering local authorities permission and funding to take more direct action involving direct engagement in stimulating/funding investment in local full fibre network rollout
 - = The methods are new, the outcomes are uncertain, the costs and risks are unclear

3.19 Deciding on the best course of action will involve some complex considerations by GE partners

3.20 Two routes are being suggested by DCMS:

- The aggregation route
- The share investment co-operative route

Which route is best, which route is best for GE, or, should GE not seek to take part in either route but instead focus on traditional models of facilitating/encouraging continued incumbent investment?

- 3.21 Clearly, this is all very new, in every sense of the word, in terms of policy, in terms of new roles for local authorities, in terms of potential risks and rewards for local authorities and other public sector partners, in terms of how well either route will work, to what extent LFFN programme and other central Government funding will be secured, and to what extent either route will deliver the expected outputs and outcomes....and all in the context of ever tightening local authority budgets/ resources
- 3.22 Both routes are very much at pilot stage. This is as much an experiment by Government as it is for local partners. The current funding on offer, although it seems generous (£200m), is a drop in the ocean. The scale of investment required to fully deploy local full fibre is massive. The funding is, we believe, intended as a catalyst to stimulate and provide a test-bed for alternative intervention routes to the established 'traditional' route of gap funding the incumbents.
- 3.23 The capacity of the new altnets to roll their aggregator business models out across the whole country is still to be tested – the sector, although increasingly well-funded via infrastructure funding from the capital markets, is nevertheless embryonic; the extent to which the new altnets are able to invest in local full fibre off network is yet to be fully tested; indeed, can full fibre across the whole country really be achieved without massive investment from the incumbents. And if the new altnet business model is genuinely scalable in a sustainable way, will the end result actually be much different from what the incumbents would have done
- 3.24 Equally, the capacity, the ability, the political will of local authorities and other public-sector partners to engage in setting up, investing in, and being party to shared co-operative new vehicles offering duct/dark fibre, is also still to be tested, as are the risks and exposure to partners.
- 3.25 No one knows the answers to these questions. The issue for GE is does it want to take part in an experiment – in piloting possible new approaches.

Recommendation

- 3.26 As a first step, GE partners need to consider the options and decide which route, if any, to follow.
- 3.27 We suggest this is considered in the context of the following over-arching points, derived in part from the GE baseline work set out earlier on in this report:
- A high proportion of households and SMEs across GE now have reasonable consumer broadband services – there are gaps in rural areas and some urban not-spots, but GE overall is now relatively well served with superfast – 30-50 Mbps download consumer broadband

- Most SMEs and households do not currently need anywhere near gigabit-capable connectivity – which is the Government’s rationale for focussing on local full fibre network deployment – but it will only be a matter of time before they do
- It takes a long time to deploy a new network infrastructure such as extensive local access full fibre – other parts of the world have already started – Ofcom suggests that the UK should start or risk being left behind. Moreover, GESP is all about looking forward, looking to the future and ensuring that GE is ‘future-ready’. This ought to include being ‘fibre-ready’
- The Government, for the first time, is offering local authorities and other local partners (NHS, schools, colleges), the opportunity to come together, to bid for money and to take action, to pilot one or more new methods of local intervention with the aim of stimulating investment in local full fibre. This is no more than a start of what will be a long road – a 10-15 year investment programme at least, if started now, if funding is available
- The consensus is that the incumbents will invest in more local full fibre network and in its near equivalent (which in BT’s case is G-Fast), but that their investment programmes are national, such that GE is not guaranteed to get as much investment as it would like; moreover rural areas are likely to be left out, or left till last again – and – SMEs may only be offered more expensive lease line services rather than gigabit consumer services
- So, without additional intervention – such as that currently on offer from DCMS under the local full fibre network programme – this may well be GE’s lot

3.28 The decision on whether to take this opportunity to take local action, along with its risks and commitments, or not, must be a local political decision. Before that decision can be taken, GE will need more information however.

4. Digital connectivity targets for GE

4.1 This section sets out current and future digital connectivity targets for GE

Summary – digital connectivity targets for GE

We recommend that GE's digital connectivity targets reflect the UK Government's latest digital connectivity targets, which focus on promoting and accelerating investment in local full fibre network by a multiplicity of providers to encourage and stimulate completion at all levels of the digital connectivity supply chain.

The UK's Government's digital connectivity targets

Two main types of digital connectivity service have evolved

- Broadband to the premises – via **fixed line** (and wireless point to point) networks
- Broadband (data services) to mobile devices via the **GSM** networks – e.g. mobile phone networks, (which also include data services in addition to voice)

Fixed line market

- There are two distinct types of fixed-line product/service and associated markets, with very different supply chains, value chains, network technologies, quality of service and pricing
 - ⇒ Consumer broadband services – public policy tends to focus on promoting consumer broadband targets speed and availability targets
 - ⇒ Lease line services – public policy tends to focus on regulation/deregulation measures to promote competition, rather than speed targets
- Consumer broadband – current (and future targets) in the UK comprise a combination of speed (usually Mbps download speed), wider service quality and, of recent, technology metrics. Current targets are best illustrated by Ofcom's open access market review which identifies three principal fixed line consumer broadband targets
 - ⇒ **standard broadband**: download speeds of up to 30 Mbit/s;
 - ⇒ **superfast broadband**: download speeds from 30 Mbit/s up to 300 Mbit/s; and
 - ⇒ **ultrafast broadband**: download speeds of 300 Mbit/s and above. Superfast broadband take-up is growing rapidly, and where it is available 47% of broadband lines were at superfast speeds by mid-2016.
- Ofcom notes though that there is no standard definition of ultrafast. The UK Government currently defines ultrafast as 100 Mbit/s or greater. Ofcom considers that the reliability with which the speed is delivered is an important attribute and expects the definition of ultrafast to evolve to take account of the importance of this reliability. Ofcom currently takes ultrafast broadband services to be those that offer a minimum download speed of 300 Mbit/s or more (a factor of ten greater than that offered by superfast). These services also offer higher upload speeds than superfast broadband. Over time Ofcom expects ultrafast technologies to evolve towards providing gigabit speeds and above – 1 Gbit/s or more
- Since Autumn 2017, the UK Government is, for the first time, promoting a particular network technology in association with ultrafast targets, namely fibre optic cable. The Government has recently shifted its focus to identifying ways to get the private sector to invest more in infrastructure – both fixed line and mobile – that can meet medium-to-long term projections of increasing use – with specific emphasis on fibre¹⁵. This points clearly to

¹⁵ Fibre optic network, from door to door, is widely recognised as the optimum network architecture in that it can handle very high bandwidths, symmetrically and can provide very high quality of service. It is expensive however to install. For this reason, a number of countries have focussed on gap funding the incumbents to use and extend legacy copper networks to delivery consumer broadband. Others have however focussed on promoting wide scale fibre deployment. The recent shift in UK government policy recognises that the UK is potentially lagging behind these countries because of

the need to establish 'full fibre' connectivity in a variety of configurations both as the principal long-term delivery medium for domestic and business premises, and to underpin investment in 5G mobile networks, which are anticipated to offer much higher throughput of data, with a concomitant demand for much more backhaul. Policy, as a consequence, is now technology specific. Quoting from Ofcom's current **Strategic Review of Digital Communications**, *one of our objectives is to make a strategic shift to encourage the large-scale deployment of new ultrafast broadband networks, including fibre direct to homes and businesses (sometimes called 'full-fibre'), as an alternative to the predominantly copper-based technologies deployed to date by Openreach. Full-fibre networks support very high speeds, ranging from several hundred Mbps to 10 Gbps or more, and should be more reliable*¹⁶.

- Technologies that will be able to deliver ultrafast services are likely to include:
 - Full fibre networks – fibre to the premises
 - G-fast enabled legacy copper networks – the latest in a long line of copper network data transmission technologies that increase the speeds that can be delivered over the legacy copper network
 - Virgin's Project Lightning – increasing speeds over the cable TV network
- Area coverage targets - various area coverage targets have been set for standard and superfast – aiming at 90-95% or more coverage, but no area coverage targets have been set for ultrafast. Instead the focus is on policy measures to increase investment by, and competition between, providers, allowing the market, supported by occasional injections of grant funding and public-private initiatives, to drive and dictate the rate and extent of new investment.
- Universal Service Obligation for broadband – in addition to the above consumer broadband targets, also for the first time, the Government is in the process of implementing a USO for broadband at 10 Mbps. It is not yet clear who and how this will be delivered but the aim is to ensure that all those that cannot access standard broadband or better, can at the very least access 10 Mbps download speed via a USO
- ***GE consumer broadband fixed-line targets – given that the GE digital connectivity strategy is intended to be forward looking, over the next, 10, 20 to 30 years, and to underpin digital connectivity objectives in the GESp, we recommend that GE focusses on ultra-fast targets, and specifically on local full fibre network targets – namely to put in place a full mix of measures that will support, enable and deliver increased investment in local full fibre networks through a variety of providers and/or through open access networks in order to optimize competition and innovation in service delivery at all levels of the digital connectivity supply chain***
- Lease line services – there is no explicit target for lease line services, instead the presumption is that increasing investment in local full fibre network infrastructure will reduce connection costs for those wanting bespoke lease line services, and, will increase service provider choice and competition, resulting in more competitive pricing. Of equal if not more significance, increasing provision of consumer broadband services delivered over local full fibre networks, will encourage/enable many existing lease line users to migrate to lower cost consumer broadband services

Mobile and wireless services targets for GE

- 4G mobile targets – the aspiration is for full coverage with interoperability between cells operated by different providers. Achieving these targets is partly dependant on further regulatory change, which is unlikely to be immediately forthcoming. It's a very difficult policy area (see the main chapter for an explanation)
- 5G – instead mobile policy is shifting in focus towards the future, as yet still developmental 5G mobile service platform, anticipated to be ready for large scale commercial rollout early in the next decade. This is dependent on 5G becoming a viable commercial technology, on industry investment appetite, on a favourable national regulatory environment, on favourable local planning and highways policy environment – and last, but by no means least, wide scale deployment of local full fibre access network, including in rural areas, required to support the much

our past focus on investing in legacy copper networks as opposed to promoting wide scale fibre deployment, and that it is time to change this and to focus on promoting fibre network deployment in order to catch up competitive advantage

¹⁶ <https://www.ofcom.org.uk/consultations-and-statements/category-1/wholesale-local-access-market-review>

higher data rates predicted for 5G, providing backhaul to the much larger number of masts, dishes, antenna, aerials anticipated to be required to support a 5G service. 5G services are anticipated to do at least four things (i) provide much faster data access to mobile devices (smart phones, tablets etc) (ii) support smart city/ smart settlement operations, for example such as assisted vehicle technology (iii) support smart industry through a plethora of as yet unidentified applications, and (iv) in conjunction with Wi-Fi/WiMax wireless technology, to play a key role in distribution of gigabit consumer broadband services over the last mile, last few hundred meters

- ***GE mobile/Wi-Fi targets - given that the GE digital connectivity strategy is intended to be forward looking, over the next, 10, 20 to 30 years, and to underpin digital connectivity objectives in the GESP, we recommend that GE focusses on 5G development and its commercial deployment, integrated with Wi-Fi/WiMAX wireless technology. There are no specific targets to set at this stage – it's too early to do so, instead, we recommend that GE initially focusses on securing funding for local pilots to help further develop and test-bed 5G and associated wireless technology, with the aim of then putting in place a full mix of local measures designed to support and enable rapid full scale commercial investment in the next decade***

Identify required targets for digital connectivity in GE

Two main types of digital connectivity service have evolved

- 4.2 Digital connectivity is provided to people via two entirely different types of technology platform and market
- Broadband to the premises – via fixed line (and wireless point to point) networks
 - Broadband (data services) to mobile devices via the GSM network

Fixed line market

- 4.3 There are two distinct types of fixed-line product/service and associated markets, with very different supply chains, value chains, network technologies, quality of service and pricing

Lease line services

- 4.4 The lease line market has been around since the 1960s – customers (usually large firms or organisations) place an order for a bespoke point-to-point lease line service.
- 4.5 Lease line services utilise a variety of network technologies from copper to fibre optic cable.
- 4.6 Theoretically any level of bandwidth and quality of service is available to any premises anywhere, subject to price and order-deployment time.
- 4.7 Customers are usually charged the connection costs from the suppliers nearest PoP¹⁷, which at circa £80-£120 per meter can be expensive if the customer is not close to the supplier's PoP; customers are then charged an annual tariff for the service, and for high levels of bandwidth, this too can be expensive.
- 4.8 Moreover, if the customer requires a symmetric service (equal download and upload speeds) and high-quality service levels, this adds to the price. For these reasons, lease line services have typically been the preserve of large companies/ organisations that can afford this sort of connectivity.

Consumer broadband services

- 4.9 The early 2000s saw the advent of what are termed consumer broadband services.
- 4.10 The rationale was to bring low cost (tariff and connection charge) basic broadband services to households and small businesses that normally would never be able to afford, let alone consider lease line connectivity. This marked what was to become a technology revolution. Mass availability and

¹⁷ Point of Presence – interconnection point on their network

adoption of consumer broadband has impacted just about every facet of economic and social life all countries, resulting in huge economic and social impacts. There is a very substantial literature base evidencing the extent and nature of these impacts.

- 4.11 Consumer broadband services are very different in almost every respect, from lease line services.
- Consumer broadband network is pre-laid to the street (rather than depending on a bespoke order from the customer as is the case with lease line services);
 - the extent of pre-investment required is therefore substantial and has resulted, in many countries (including in the UK) on reliance on leveraging the existing telephone copper and cable TV networks, because these networks are already deployed at the local access level and hence avoid the massive investment costs of deploying new network; leveraging these networks also means that in many cases, connection costs are minimal compared with a bespoke lease line service, because these networks 'already run down your street or a street near you'.
 - The consumer broadband market, guided by policy and regulation, has focussed on offering as cheap as possible services, with absolute minimal connection costs and minimal lead times from the point of order.
 - The consumer broadband market also focusses on offering what are known as retail products i.e. internet access, often packaged with TV, phone and other consumer services – the lease line market in contrast typically offers what we might term 'raw connectivity' in the form of an ethernet transmission service, leaving it to the customer to configure to their own requirements. This involves specialist technical knowledge. Consumer broadband services do not. As such they are often termed 'plug and play'
- 4.12 Consumer broadband has essentially become an off-the-shelf mass market that has enabled the masses to afford and start using broadband.
- 4.13 There are limitations to bandwidth and service quality however.
- 4.14 A combination of reliance on legacy technologies (the copper telephone network and the cable TV network, neither of which were originally designed for broadband), in conjunction with the way BT and Virgin Media have configured operation of their networks, tend to mean that consumer broadband services can:
- Only offer limited bandwidth (unlike lease line services)
 - Moreover, services are not usually symmetric, but the download speed is configured to be much greater than the upload speed (symmetric services is not an issue for lease line services)
 - Services are also contended i.e. a given capacity is shared by households in a street, so if everyone is online at once, the available bandwidth per household drops (lease line services will include a guaranteed minimum bandwidth)
 - The quality of service (in terms of down time/ repair time and nature of transmission) is lower than available via a lease line service
- 4.15 These factors can be issues for some users – with demand for video/TV download/ content growing, bandwidth limitations coupled with contention can be a problem; businesses and those working from home also often need to upload as much as they download so lack of symmetry can be an issue; and an increasing number of business applications require both symmetric bandwidth and higher quality transmission metrics than are usually available via consumer broadband
- 4.16 Consumer broadband is improving all the time however. In particular, maximum available download speeds have increased substantially, from 0.5 Mbps download speed in the early 2000s when

broadband first became widely available, to 1-2 Mbps download speed by the mid-2000s, to 5-10 Mbps by the end of the decade, rising rapidly to 20, 30, 50, 70, 100 Mbps download speed today.

- 4.17 These improvements have been enabled by two things – improved transmission technologies (both over copper and cable TV networks) and replacement of parts of the network with fibre optic cable

Improvements in BT's copper telephone network

- Improved transmission protocols/ technologies – in the case of the copper telephone network, ADSL, SDSL and VDSL, and now, G-Fast – have enabled faster and faster download speeds
- Replacement of some of the copper network with fibre optic cable has enabled delivery of faster and faster consumer broadband (fibre optic cable can support unlimited bandwidth; copper cable cannot and moreover, is highly distance sensitive).
 - = In the early 2000s, to support growing demands for consumer bandwidth, BT implemented the 'exchange enablement programme', in part with some costs subsidised by the Government/Regional Development Agencies, which replaced copper backhaul to the exchange from the core network with fibre;
 - = then in this decade, BT implemented the cabinet enablement programme, replacing the copper link from the exchange to the cabinet with fibre.
 - = BT is now starting to embark on a fibre to the premises programme, comprising a mix of replacing the final length of copper, from the cabinet to the premises with fibre (or with an entirely parallel fibre network) and part replacement of the final copper loop, e.g. to the pole coupled with deployment of yet faster copper transmission technology (G-Fast) which can support up to 1Gbps over very short copper loop lengths

- 4.18 Governments' broadband policy speed targets are regularly updated to reflect both improving achievable download speeds and growing consumer demand – driven in particular over the last 5-years by exponential growth in demand for applications using video content. Video content, particularly HD content is inherently data rich, and despite ever-better compression technology, reducing the effective size of data-heavy content, the demand for bandwidth has grown exponentially.

- 4.19 Whilst a large proportion of households and to a lesser extent, business premises, have benefited from cheap faster consumer broadband, not everyone has:

- A proportion of households and business premises in rural areas have not benefited from these network upgrades and as a consequence, can still only access the sorts of speeds available in the early 2000s
- Business clusters in urban areas have been largely left out
- Pockets of households in urban areas have also been left out

Broadband service availability targets

- 4.20 Government policy towards the lease line and the consumer broadband markets comprises a mix of regulation (via Ofcom) and in the case of consumer broadband, given the mass nature of the market, service availability targets

Consumer broadband service availability targets

- 4.21 Digital connectivity targets are set by the European Commission for member states and by domestic governments, including our own.
- 4.22 Targets for available services are set with explicit (but sometimes implicit) reference to a combination of three metrics:

- (a) availability (geographic coverage) of services measured by speed (Mbps) and other service quality metrics¹⁸ and
- (b) degree of competition and price competitiveness
- (c) and sometimes by type of network technology – and whether it was pre-installed or was subject to customer order – and the associated connection costs.

4.23 These three factors can make for a complicated mix – a mix which has changed over time

- In the UK, from the advent of consumer broadband in the early 2000s to 2017, fixed line consumer broadband targets focussed on available download speed.
 - = Reference to symmetry, contention and other service quality levels was left aside because the legacy networks being used to provide mass market consumer broadband could only deliver limited performance with regard to these other metrics
 - = Reference to type of technology as a target was also left aside because of the focus on leveraging the legacy copper telephone network and cable TV network. The technology was taken as a given, but more than this, any reference to deployment of fibre to the premises was downplayed so as not to distract from the objective of leveraging legacy network in order to get the UK online, quickly, at least cost
- From mid-2017, technology is now included as a target, with explicit reference made, for the first time to fibre optic network infrastructure as the principal digital connectivity infrastructure of the future

Current European Commission consumer broadband targets

4.24 The European Commission has set and revised targets through the digital agenda; national Governments have either reflected these targets or proposed variations. The current EC targets are set out in <https://ec.europa.eu/digital-single-market/en/broadband-strategy-policy>

Current EC targets

The following objectives have been set in the field of 'provision of broadband':

- Basic broadband for all citizens by 2013: this target is met, as satellite broadband is available (coverage 100%) in every Member State.
- Coverage of Next Generation Networks (NGN): 30 Mbps or more for all citizens by 2020.
- Use of Next Generation Networks (NGN): 100 Mbps or more by 50% of households by 2020.

In addition, the European Commission adopted a strategy on Connectivity for a European Gigabit Society in September 2016. This strategy addresses the availability and take-up of very high capacity networks, which will enable the widespread use of new products, services and applications in the Digital Single Market.

The three main strategic objectives for 2025 are:

- Access to 1 Gbps for all schools, transport hubs and main providers of public services and digitally intensive enterprises,

¹⁸ The most common quoted service metric is download speed. Ofcom and the National Infrastructure Commission (NIC) are now also emphasizing other service metrics, including upload speed (degree of symmetry), down-time (stability) and other quality of service indicators. Moreover, for the first time, targets are being expressed not just in terms of speed but also in terms of type of technology. This is a result of the very recent formal recognition by Government that relying on legacy copper networks alone is not enough (for the reasons set out above) and that industry needs to invest far more in local access fibre networks

- Access to download speeds of at least 100 Mbps to be upgraded to 1 Gbps for all European households, and
- Uninterrupted 5G wireless broadband coverage for all urban areas and major roads and railways.

<https://ec.europa.eu/digital-single-market/en/broadband-strategy-policy>

Ofcom's consumer broadband targets for the UK

- 4.25 The UK has, to an extent, followed EC broadband targets, but with a degree of variation. David Cameron's government adopted slightly lower targets for example.
- 4.26 The current Government's targets are best articulated by Ofcom the telecoms regulator, as set out in Ofcom's Wholesale Open Access Market Review¹⁹. This defines three types of broadband service, with associated download speeds, based on an analysis of the market

Ofcom's analysis of consumer broadband speeds

Download speed is prominent in the marketing of these broadband services and in our analysis, we make a distinction between services with download speeds as follows:

- **standard broadband:** download speeds of up to 30 Mbit/s;
- **superfast broadband:** download speeds from 30 Mbit/s up to 300 Mbit/s; and
- **ultrafast broadband:** download speeds of 300 Mbit/s and above. Superfast broadband take-up is growing rapidly, and where it is available 47% of broadband lines were at superfast speeds by mid-2016.

There is no standard definition of ultrafast. The UK Government currently defines ultrafast as 100 Mbit/s or greater. We also consider that the reliability with which the speed is delivered is an important attribute and expect the definition to ultrafast to evolve to take account of the importance of this reliability. We currently take ultrafast broadband services to be those that offer a minimum download speed of 300 Mbit/s or more (a factor of ten greater than that offered by superfast). These services also offer higher upload speeds than superfast broadband. Over time we expect ultrafast technologies to evolve towards providing gigabit speeds and above – 1 Gbit/s or more

Technology targets – DCMS's recent focus on local full fibre networks as the priority for the UK's future connectivity

- 4.27 Until the UK Government's very recent shift in policy focus from delivering service levels to delivering infrastructure, it was not acceptable to be technology specific in policy²⁰. Instead there was strong encouragement to keep policy technology neutral and instead focus on setting service level targets such as speed. The Government has recently shifted its focus to identifying ways to get the private sector to invest more in infrastructure – both fixed line and mobile – that can meet medium-to-long term projections of increasing use – with specific emphasis on fibre²¹. This points clearly to the need to

¹⁹ <https://www.ofcom.org.uk/consultations-and-statements/category-1/wholesale-local-access-market-review>

²⁰ This was Government policy at the time which reflected European Commission policy. The rationale for ensuring that policy and grant funding remained technology neutral was two fold (i) to prevent policy makers seeking to second guess the best technology mix but instead leaving it to the market and competition to propose the optimal technology mix (ii) secondly to encourage technology innovation. There was also a body of opinion that argued that ensuring technology neutrality was the result of effective lobbying by the incumbents as this ensured that their legacy infrastructures remained accepted technologies to gap fund and prevented full fibre becoming the preferred technology.

²¹ Fibre optic network, from door to door, is widely recognised as the optimum network architecture in that it can handle very high bandwidths, symmetrically and can provide very high quality of service. It is expensive however to install. For this reason, a number of countries have focussed on gap funding the incumbents to use and extend legacy copper networks to delivery consumer broadband. Others have however focussed on promoting wide scale fibre deployment. The recent shift in UK government policy recognises that the UK is potentially lagging behind these countries because of

establish 'full fibre' connectivity in a variety of configurations both as the principal long-term delivery medium for domestic and business premises, and to underpin investment in 5G mobile networks, which are anticipated to offer much higher throughput of data, with a concomitant demand for much more backhaul. Policy, as a consequence, is now technology specific. Quoting from Ofcom's current **Strategic Review of Digital Communications**, *one of our objectives is to make a strategic shift to encourage the large-scale deployment of new ultrafast broadband networks, including fibre direct to homes and businesses (sometimes called 'full-fibre'), as an alternative to the predominantly copper-based technologies deployed to date by Openreach. Full-fibre networks support very high speeds, ranging from several hundred Mbps to 10 Gbps or more, and should be more reliable*²².

- Technologies that will be able to deliver ultrafast services are likely to include:
 - = Full fibre networks – fibre to the premises
 - = G-fast enabled legacy copper networks – the latest in a long line of copper network data transmission technologies that increase the speeds that can be delivered over the legacy copper network
 - = Virgin's Project Lightning – increasing speeds over the cable TV network

Universality targets

- 4.28 An additional target also needs to be considered, the recently proposed extension of the Universal Service Obligation (USO) for telephony (voice) to now include broadband. The USO has been in operation since the GPO²³ was first privatised. The UK, similar to most other advanced industrial countries, is now in the process of putting in place a digital connectivity (broadband) USO. Initially a download speed of 30 Mbps was discussed. The Digital Economy Act approved on 27 April 2017, however rejected a national minimum connection speed of 30 Mbps, settling instead for a 10Mbps minimum. (This despite the fact that, as recently as February 2017, the House of Lords declared 10Mbps 'unfit for usage in a very short time'²⁴). This was seen to be expedient in the context of approving legislation during the last sitting of Parliament before the election

Recommended fixed line targets for the GE digital infrastructure strategy

- 4.29 We recommend that the GE digital infrastructure strategy sets its initial targets in line with Ofcom's analysis, but with a particular emphasis on the LFFN programme approach which emphasises 'giga-bit capable services but which also for the first time, moves from just discussing download speeds as an objective to specifying a particular technology – fibre, on the grounds that it can support ultra-fast speeds plus better service level metrics

Recommended mobile targets for GE

- 4.30 The mobile arena is simpler than the fixed line arena in terms of speed/service specification targets. Targets focus on availability/ coverage by technology, currently 4G and in the future 5G
- 4.31 We suggest that GE's mobile targets are to:
- Seek to ensure 4G availability across all areas, and, Ofcom regulations permitting, to seek to ensure inter-operability e.g. easy switching between cells and different providers

our past focus on investing in legacy copper networks as opposed to promoting wide scale fibre deployment, and that it is time to change this and to focus on promoting fibre network deployment in order to catch up competitive advantage

²² <https://www.ofcom.org.uk/consultations-and-statements/category-1/wholesale-local-access-market-review>

²³ General Post Office – predecessor to BT

²⁴ Hansard

- Seek to take a lead role in piloting 5G and as soon as mass deployment takes place – the Government thinks early next decade), GE's target should be to ensure rapid rollout in both urban and rural areas, with the aim of moving towards full coverage

Wi-Fi targets

- 4.32 Wi-Fi services/access, for the purposes of this study, are usefully divided into two types
- Wi-Fi available in your house or office, via the wireless router in your bedroom or office. The backhaul for the Wi-Fi is the 'fixed-line' service to your router. We might term this 'private Wi-Fi', which is password protected and can be regarded as an extension of your fixed line service
 - Wi-Fi available in the public realm, in public buildings, in visitor destinations. Although these services will require a fixed line back haul, they are conceptually different from home or office Wi-Fi, in that they are intended for public (mobile) use
- 4.33 Wi-Fi targets in strategies tend to focus on the latter rather than the former
- 4.34 Some strategies also seek to promote Wi-Fi targets in addition to mobile targets, most commonly in relation to availability of free or charged for Wi-Fi services in certain parts of the public realm, in public buildings and in some cases in visitor establishments such as cafes etc. Targets are set in terms of availability, cost and speed.
- 4.35 Alternatively, Wi-Fi availability is not set as an overall target but instead is treated on a project by project basis.
- 4.36 A number of Wi-Fi projects have run into difficulty however, in terms of overlap/competition with privately provided Wi-Fi (restaurants/ cafes etc). Issues have been competition and state aid related.
- 4.37 Looking forward, public realm Wi-Fi and 5G are likely to be closely inter-linked. They are likely to play a major role in future connectivity, but it is not yet clear what the relationships will be, particularly because 5G is still being developed.
- 4.38 We therefore suggest that GE's public realm Wi-Fi targets are similar to its 5G targets but will depend on how the inter-relationship between the two technologies evolves commercially.

5. Mapping and gapping – current consumer coverage

Summary – current consumer broadband coverage across GESP

Fixed line consumer broadband

With reference to Ofcom's three consumer broadband service definitions (standard, super-fast and ultra-fast broadband)

- GE has virtually no ultra-fast (gigabit-capable) consumer broadband connectivity, neither does much of the rest of the UK, with the exception of those cities that are benefiting from BT's focussed FttH rollouts and from joint ventures with the new breed of altnets which are starting to deploy gigabit-capable infrastructure across parts the city
- GE is however reasonably well served by super-fast (also termed NGA) consumer broadband, but gaps remain. At the top end of the super-fast spectrum a third of households and 16% of businesses can access download speeds of 100 Mbps or more. Taking 30 Mbps as the lower end of the NGA speed benchmark, 86% of households and 67% of businesses can access download speeds of 30 Mbps or more
- But this also means that 14% of households and 33% of business premises still cannot access 30 Mbps download speeds in GE
- 10 Mbps is today regarded as the minimum acceptable download speed and will be the threshold set by the new broadband USO under discussion in parliament. Just under 10% of households and business premises in GE cannot access 10 Mbps (this is nearer 20% for Mid Devon)

Download speed availability – households and business premises – across GE

100 Mbps download speed target

- 35% of households are in areas that offer download speeds of 100 Mbps or more
- 16% of businesses are in areas that offer download speeds of 100 Mbps or more

30 Mbps download speed target

- 86% of households are in areas that offer download speeds of 30 Mbps or more (this also means that 14% of households cannot access 30 Mbps download speeds)
- 67% of businesses are in areas that offer download speeds of 30 Mbps or more (this also means that 33% of business premises cannot access 30 Mbps download speeds)

Business connectivity – by type of premises – less than 30 Mbps download speed

- 38% of factory business premises are in areas offering less than 30 Mbps download speed
- 35% of warehouse business premises are in areas offering less than 30 Mbps download speed
- 34% of office business premises are in areas offering less than 30 Mbps download speed
- 30% of retail business premises are in areas offering less than 30 Mbps download speed

10 Mbps download speed target

- 9% of households cannot access 10 Mbps (this is nearer to 20% for Mid Devon)
- 9% of business premises are in areas offering download speeds of less than 10 Mbps (this is nearer 20% for Mid Devon)

Mobile coverage

- **4G coverage and gaps** - mapping of 4G coverage, and hence of 4G coverage gaps in GE, at a sufficiently granular level to be meaningful is not yet possible, because MNOs²⁵ are not prepared to release their data because of commercial sensitivity reasons. Ofcom is seeking to address this at present, but at the time of writing, it is unclear to what extent and when this will be achieved
- CDS states that there are 7,000 households in Devon and Somerset with no outdoor 4G coverage; this will translate into a higher number still of premises with no indoor coverage; and a proportion of those with coverage may only be served by a single Mobile Network Operator (MNO), but will still show as having outdoor coverage on Ofcom's maps - so there will be many more consumers whose network does not serve both their home and work address, for instance
- **5G coverage and gaps** - 5G technology is still not finalised. The Government's 5G strategy anticipates deployment to commence early in the next decade. The Government's strategy identifies 5G as a transformational technology, with use-cases and impacts way beyond the way 4G is currently used. 5G will provide very fast higher quality connectivity to smart phones/ Tablets etc, but it is also expected to be embedded in and utilised in smart city and industrial applications

This digital strategy is in response to, and focusses on DCMS's recent announcements that NGA²⁶ is done and that the UK now needs to move on to local full fibre network deployment

- 5.1 But before focussing on LFFN, it will be useful to understand to what extent NGA is done in the study area. Discussions with key local stakeholders, including CDS personnel, suggest that NGA is far from done. From a local economic policy perspective and from a local social policy perspective this is quite unacceptable.

National context

- 5.2 Before we look at the local NGA picture in more detail, let's start with the national context.
- 5.3 A recent article from the Guardian features the results of a national Which survey. A total of 1,709 telecoms customers were surveyed between June and July. Key findings were:
- 53% of households have had difficulties with their broadband, singling out Virgin Media, TalkTalk, Sky and BT the most likely to experience an issue²⁷
 - As few as one in 10 households receive the super-fast broadband speeds promised in adverts
 - Connection drop-outs were a frequent problem for 17% of users, with 8% of households reporting that they suffered from no connection at all for hours or days at a time

UK at risk of falling behind international competitors

Guardian 21/10/17 Patrick Collinson

²⁵ Mobile network operators

²⁶ NGA, short for Next Generation Access – generally associated with BT's upgrade of its legacy copper network bringing fibre to the cabinet, delivering consumer broadband downloads speeds of 30-70 Mbps. - see <https://www.ofcom.org.uk/consultations-and-statements/category-1/wholesale-local-access-market-review> - for a fuller explanation

²⁷ Reflecting the high market share of these service providers

Half of all broadband users in the UK are getting a raw deal from their supplier, with slow speeds, rising prices and router failures, according to a highly critical assessment of internet services.

Consumer group Which found that 53% of households have had difficulties with their broadband, with customers of Virgin Media, TalkTalk, Sky and BT the most likely to experience an issue.

As few as one in 10 households receive the super-fast broadband speeds promised in adverts, said Which one third of TalkTalk's customers complained about "very slow" broadband speeds, as well as 22% of BT internet users.

Connection drop-outs were a frequent problem for 17% of users, with 8% of households reporting that they suffered from no connection at all for hours or days at a time.

Price rises for landline rentals have spurred widespread customer dissatisfaction. BT introduced its third price rise in 18 months at the start of the year, forcing it to deny it was squeezing customers after paying £1.2bn for Champions League football rights.

Virgin customers' top complaint was about price increases, said Which, with 38% of users angry over increased line rental costs.

A total of 1,709 telecoms customers were surveyed between June and July. Alex Neill, of Which, said: "The regulator must now deliver on its plans to improve the information customers get about speeds when they sign up to a provider and allow them to easily exit a contract if they're not getting what they've been promised."

Ofcom, which regulates broadband suppliers, said: "We completely agree that broadband providers must up their game."

It recently ordered suppliers to give more realistic information about speeds, and later this year will introduce a compensation deal for households that suffer delayed repairs, late installations and missed engineer appointments.

The UK lags behind countries including the US, the Netherlands and Japan for 4G and broadband speeds, according to a report last week by the National Infrastructure Commission. Lord Adonis, chairman of the commission, said: "The UK risks falling behind our international competitors if we don't invest in the latest ultrafast and fibre technology – broadband providers must also step up to the plate and improve the services they currently deliver to our homes and businesses."

TalkTalk said it was "disappointed" by the Which findings and that recent investment had led to fewer faults and quicker repair times. Virgin Media said it is one of the least-complained about broadband providers and the majority of customers get their advertised speed.

Dan Howdle, of comparison site cable.co.uk, said: "We are 31st in the world out of 200 countries on speeds and in the cheapest third when it comes to cost."

Mapping and gapping NGA in Greater Exeter – what the stats tell us

- 5.4 The following Figures and charts show households and businesses by available download speed across Devon's Local Authority Districts (LADs). The data are provided by Point Topic and the analysis is undertaken by Adroit Economics
- 5.5 Details of classifications of the Point Topic data are provided in the appendices.
- 5.6 The Figures and charts show numbers and proportions of households and business premises, per LAD, by available download speed (Mbps) as at 2016 (the latest available data). Availability of downloads speeds are analysed by:
 - Speed band – sub 10, 10-30, 30-100, 100-1000, and
 - Maximum download speed availability – sub 10, sub 30, sub 100, sub 1000
- 5.7 Business connectivity is also analysed by type of business premises – office, retail, warehouse, factory and other
- 5.8 The analysis also includes a focus on sub 10 Mbps availability

Number and distribution of households by availability of download speed by speed band in GE

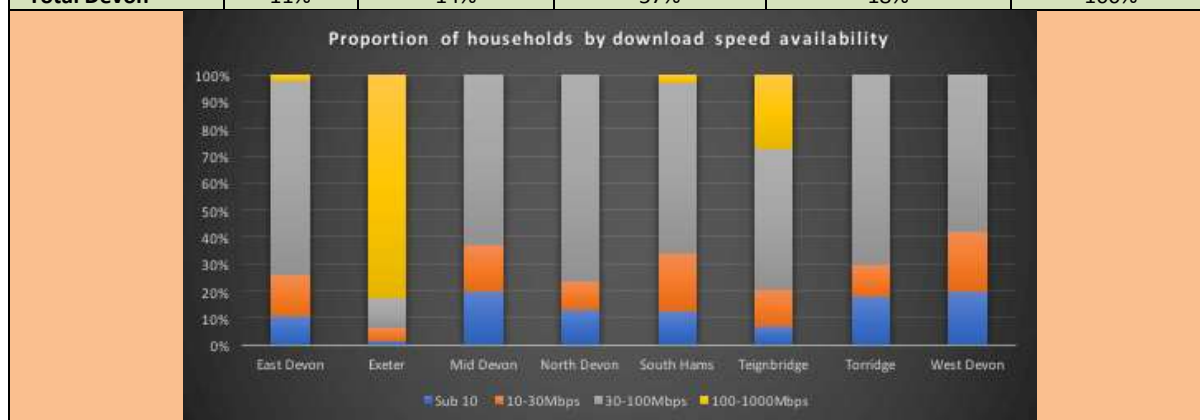
- 9% of households are in areas offering download speeds of less than 10 Mbps
- 12% are in areas offering between 10-30 Mbps
- 50% are in areas offering 30-100 Mbps

Figure 5.1: Number of households by download speed band

	Sub 10	10-30Mbps	30-100Mbps	100-1000Mbps	Grand Total
East Devon	7,213	10,073	47,931	1,425	66,642
Exeter	875	2,408	5,830	44,164	53,277
Mid Devon	6,966	5,886	22,204	34	35,090
North Devon	5,535	4,649	33,190	0 ²⁸	43,374
South Hams	5,449	9,399	27,252	1,385	43,485
Teignbridge	4,049	8,047	31,177	16,340	59,613
Torridge	5,495	3,782	21,883	0	31,160
West Devon	5,041	5,500	14,604	6	25,151
Total GESP	19,104	26,414	107,141	61,963	214,622
Total Devon	40,623	49,743	204,071	63,354	357,792

Figure 5.2: Distribution of households by download speed band

	Sub 10	10-30Mbps	30-100Mbps	100-1000Mbps	Grand Total
East Devon	11%	15%	72%	2%	100%
Exeter	2%	5%	11%	83%	100%
Mid Devon	20%	17%	63%	0%	100%
North Devon	13%	11%	77%	0%	100%
South Hams	13%	22%	63%	3%	100%
Teignbridge	7%	13%	52%	27%	100%
Torridge	18%	12%	70%	0%	100%
West Devon	20%	22%	58%	0%	100%
Total GESP	9%	12%	50%	29%	100%
Total Devon	11%	14%	57%	18%	100%



Number and distribution of households by maximum download speed availability in GE

- 14% of households are in areas that offer download speeds of less than 30 Mbps

²⁸ Zero post codes, rather than reflecting missing data

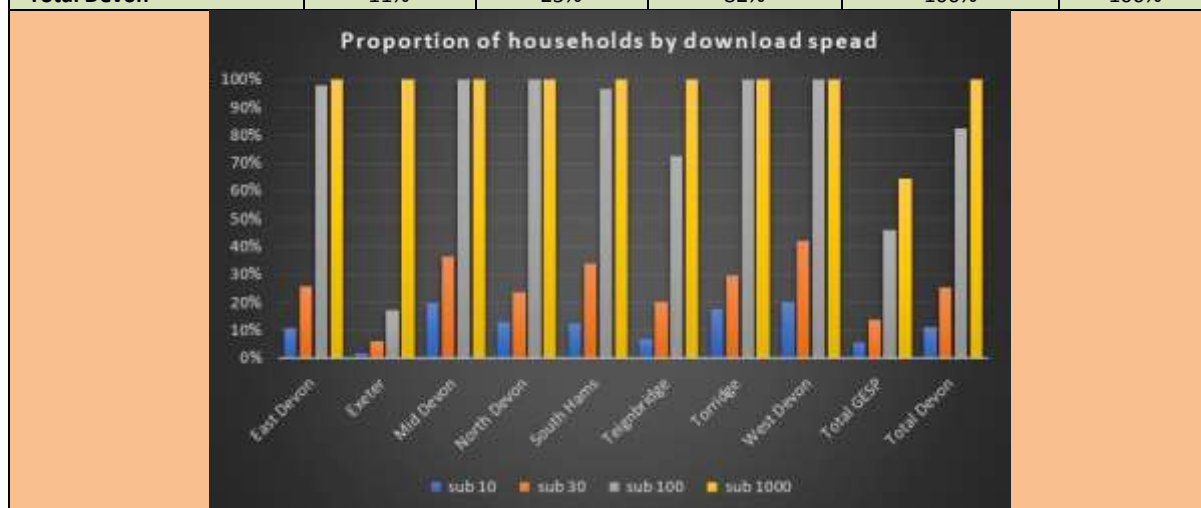
- 65% of households are in areas that offer download speeds of less than 100 Mbps

Figure 5.3: Number of households by maximum download speed availability

	sub 10	sub 30	sub 100	sub 1000	total
East Devon	7,213	17,286	65,217	66,642	66,642
Exeter	875	3,283	9,113	53,277	53,277
Mid Devon	6,966	12,852	35,056	35,090	35,090
North Devon	5,535	10,183	43,374	43,374	43,374
South Hams	5,449	14,848	42,100	43,485	43,485
Teignbridge	4,049	12,096	43,273	59,613	59,613
Torridge	5,495	9,277	31,160	31,160	31,160
West Devon	5,041	10,541	25,145	25,151	25,151
Total GESP	19,103	45,517	152,659	214,622	214,622
Total Devon	40,623	90,366	294,438	357,792	357,792

Figure 5.4: Distribution of households by maximum download speed availability

	sub 10	sub 30	sub 100	sub 1000	total
East Devon	11%	26%	98%	100%	11%
Exeter	2%	6%	17%	100%	2%
Mid Devon	20%	37%	100%	100%	20%
North Devon	13%	23%	100%	100%	13%
South Hams	13%	34%	97%	100%	13%
Teignbridge	7%	20%	73%	100%	7%
Torridge	18%	30%	100%	100%	18%
West Devon	20%	42%	100%	100%	20%
Total GESP	6%	14%	46%	65%	100%
Total Devon	11%	25%	82%	100%	100%



Business connectivity

Number and distribution of businesses by availability of download speed by speed band in GE

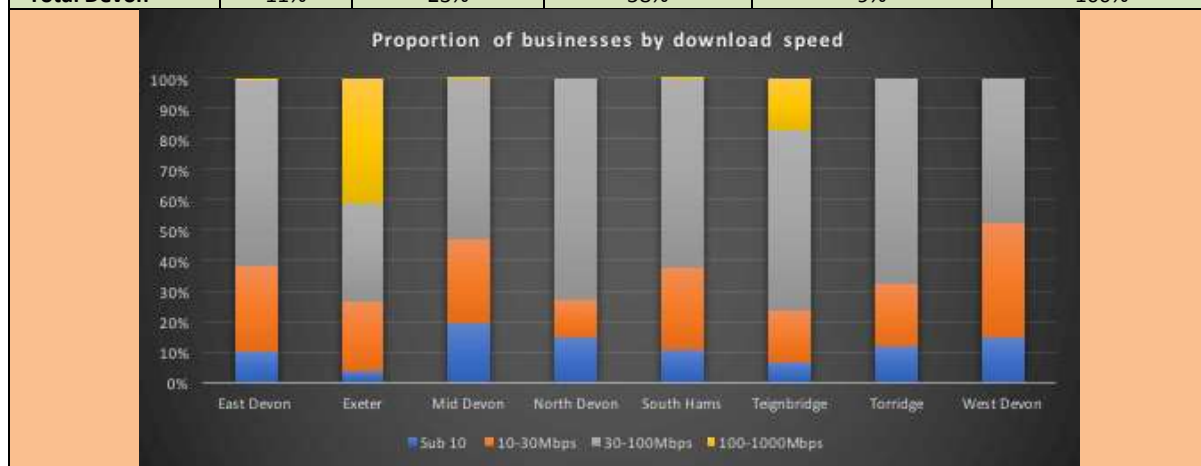
- 9% of business premises are in areas offering download speeds of less than 10 Mbps
- 24% are on areas offering between 10-30 Mbps
- 52% are in areas offering 30-100 Mbps

Figure 5.5: Number of business by download speed band

	Sub 10	10-30Mbps	30-100Mbps	100-1000Mbps	Total per LAD
East Devon	613	1,657	3,648	38	5,956
Exeter	166	1,151	1,587	2,036	4,940
Mid Devon	575	813	1,566	2	2,957
North Devon	736	608	3,617	-	4,961
South Hams	536	1,340	3,065	12	4,954
Teignbridge	326	850	2,911	852	4,938
Torridge	349	611	2,009	-	2,969
West Devon	295	734	948	-	1,977
Total GESP	1,680	4,472	9,712	2,927	18,790
Total Devon	3,596	7,764	19,351	2,939	33,651

Figure 5.6: Distribution of business by download speed band

	Sub 10	10-30Mbps	30-100Mbps	100-1000Mbps	Total per LAD
East Devon	10%	28%	61%	1%	100%
Exeter	3%	23%	32%	41%	100%
Mid Devon	19%	28%	53%	0%	100%
North Devon	15%	12%	73%	0%	100%
South Hams	11%	27%	62%	0%	100%
Teignbridge	7%	17%	59%	17%	100%
Torridge	12%	21%	68%	0%	100%
West Devon	15%	37%	48%	0%	100%
Total GESP	9%	24%	52%	16%	100%
Total Devon	11%	23%	58%	9%	100%



Number and distribution of business premises by maximum download speed availability in GE

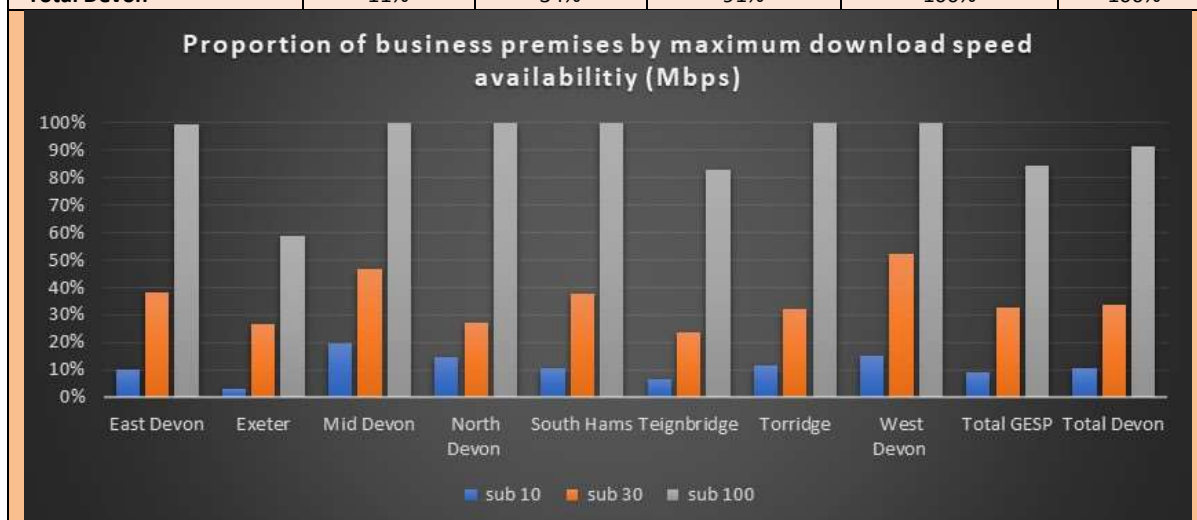
- 33% of businesses are in areas that offer download speeds of less than 30 Mbps
- 84% of businesses are in areas that offer download speeds of less than 100 Mbps

Figure 5.7: Number of business premises by maximum download speed availability

	sub 10	sub 30	sub 100	sub 1000	total
East Devon	613	2,271	5,918	5,956	5,956
Exeter	166	1,317	2,905	4,940	4,940
Mid Devon	575	1,389	2,955	2,957	2,957
North Devon	736	1,344	4,961	4,961	4,961
South Hams	536	1,876	4,942	4,954	4,954
Teignbridge	326	1,175	4,086	4,938	4,938
Torridge	349	960	2,969	2,969	2,969
West Devon	295	1,029	1,977	1,977	1,977
Total GESP	1,680	6,152	15,864	18,790	18,790
Total Devon	3,596	11,361	30,712	33,651	33,651

Figure 5.8: Distribution of business premises by maximum download speed availability

	sub 10	sub 30	sub 100	sub 1000	total
East Devon	10%	38%	99%	100%	100%
Exeter	3%	27%	59%	100%	100%
Mid Devon	19%	47%	100%	100%	100%
North Devon	15%	27%	100%	100%	100%
South Hams	11%	38%	100%	100%	100%
Teignbridge	7%	24%	83%	100%	100%
Torridge	12%	32%	100%	100%	100%
West Devon	15%	52%	100%	100%	100%
Total GESP	9%	33%	84%	100%	100%
Total Devon	11%	34%	91%	100%	100%



Analysis of business connectivity by type of businesses premises

- 38% of factory business premises are in areas offering less than 30 Mbps download speed

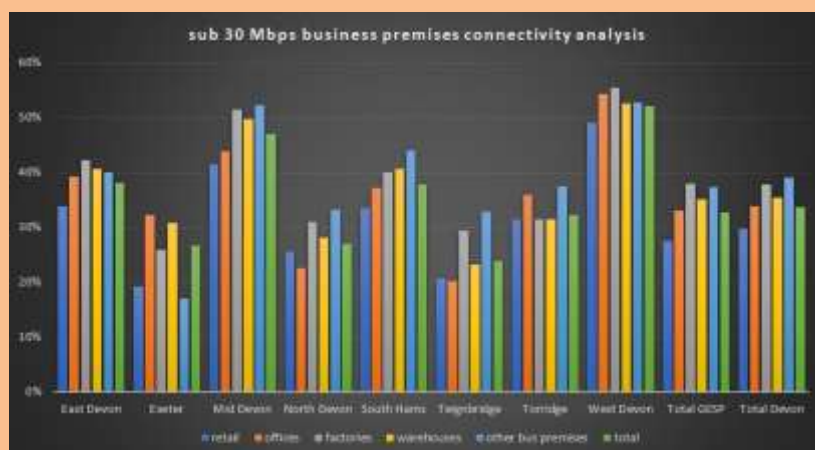
- 35% of warehouse business premises are in areas offering less than 30 Mbps download speed
- 34% of office business premises are in areas offering less than 30 Mbps download speed
- 30% of retail business premises are in areas offering less than 30 Mbps download speed

Figure 5.9: Number of business premises, by type, in areas offering less than 30 Mbps download speed

	retail	offices	factories	warehouses	other	total sub 30
East Devon	772	309	483	555	152	2,271
Exeter	318	544	118	316	21	1,317
Mid Devon	347	231	420	303	88	1,389
North Devon	557	148	299	257	83	1,344
South Hams	534	297	557	343	145	1,876
Teignbridge	367	144	346	237	82	1,175
Torridge	368	130	237	159	66	960
West Devon	383	171	232	172	71	1,029
Total GESP	1,804	1,228	1,367	1,410	343	6,152
Total Devon	3,645	1,974	2,692	2,342	708	11,361

Figure 5.10: Proportion of business premises, by type, in areas offering less than 30 Mbps download speed

	retail	offices	factories	warehouses	other	Total sub 30
East Devon	34%	39%	42%	41%	40%	38%
Exeter	19%	32%	26%	31%	17%	27%
Mid Devon	41%	44%	51%	50%	52%	47%
North Devon	26%	23%	31%	28%	33%	27%
South Hams	34%	37%	40%	41%	44%	38%
Teignbridge	21%	20%	29%	23%	33%	24%
Torridge	31%	36%	31%	32%	38%	32%
West Devon	49%	54%	55%	52%	53%	52%
Total GESP	28%	33%	38%	35%	37%	33%
Total Devon	30%	34%	38%	35%	39%	34%



Focus on sub-10 Mbps download speed

- 5.9 The Figures below show the number and proportion of households and businesses, by local authority area in GESP, that cannot access at least 10 Mbps download speed. Below 10 Mbps can be regarded as 'poor broadband'. The opportunity to access 10 Mbps as a minimum is regarded as important, as

indicated by Government policy, by Ofcom and in particular with reference to the 10 Mbps threshold being set for the proposed broadband USO²⁹

Sub-10 Mbps household connectivity in GESP - households

5.10 On average across GE, just under 10% (19,104 households) cannot access at least a 10 Mbps download speed (the figure is nearer 20% in Mid Devon).

5.11 Figures 5.11 and 5.12 show that

- An average of 8.9% of households in GESP are in areas offering download speeds of less than 10 Mbps (compared with 11.4% in Devon as a whole)
- 3.1% are in areas offering less than 5 Mbps (compared with 4.2% in Devon as a whole), and
- 1.2% are in areas offering less than 3 Mbps (compared with 1.8% in Devon as a whole)

Figure 5.11: Households – sub 10 Mbps – number by download speed availability

	up to 1	up to 3	up to 5	up to 7	up to 9
East Devon	59	1,009	2,894	4,869	7,213
Exeter	-	71	224	519	875
Mid Devon	111	900	2,143	4,284	6,966
Teignbridge	44	495	1,460	2,539	4,049
Total GESP	214	2,474	6,722	12,210	19,104

Figure 5.12: Households – sub 10 Mbps – proportion by download speed availability

	up to 1	up to 3	up to 5	up to 7	up to 9
East Devon	0.1%	1.5%	4.3%	7.3%	10.8%
Exeter	0.0%	0.1%	0.4%	1.0%	1.6%
Mid Devon	0.3%	2.6%	6.1%	12.2%	19.9%
Teignbridge	0.1%	0.8%	2.4%	4.3%	6.8%
Total GESP	0.1%	1.2%	3.1%	5.7%	8.9%

²⁹ Universal Service Obligation



Sub-10 Mbps connectivity – businesses

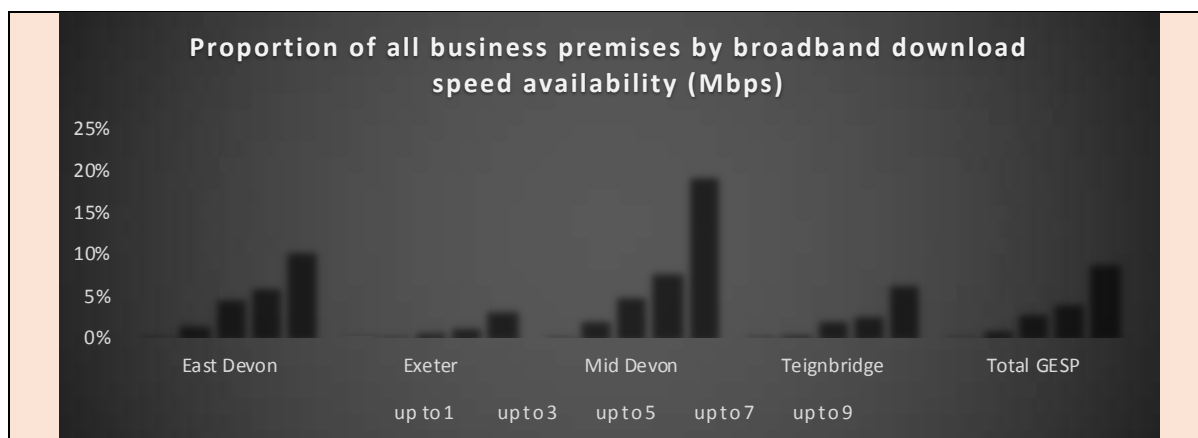
- 5.12 On average across GE, just under 10% (1,680 business premises) cannot access at least a 10 Mbps download speed (the figure is nearer 20% in Mid Devon).
- 5.13 Figures 5.13 and 5.14 show that
- an average of 8.9% of business premises in GE are in areas offering download speeds of less than 10 Mbps (compared with 10.7% across Devon as a whole)
 - 3.2% are in areas offering less than 5 Mbps (compared with 3.8% across Devon as a whole), and
 - 1.1% are in areas offering less than 3 Mbps (compared with 1.5% across Devon as a whole)

Figure 5.13: Business – sub 10 Mbps – number by download speed availability

	up to 1	up to 3	up to 5	up to 7	up to 9
East Devon	9	103	292	375	613
Exeter	-	13	44	65	166
Mid Devon	3	64	151	231	575
Teignbridge	7	25	106	144	326
Total GESP	19	205	593	815	1,680

Figure 5.14: Business – sub 10 Mbps – proportion by download speed availability

	up to 1	up to 3	up to 5	up to 7	up to 9
East Devon	0.1%	1.7%	4.9%	6.3%	10.3%
Exeter	0.0%	0.3%	0.9%	1.3%	3.4%
Mid Devon	0.1%	2.2%	5.1%	7.8%	19.5%
Teignbridge	0.1%	0.5%	2.1%	2.9%	6.6%
Total GESP	0.1%	1.1%	3.2%	4.3%	8.9%

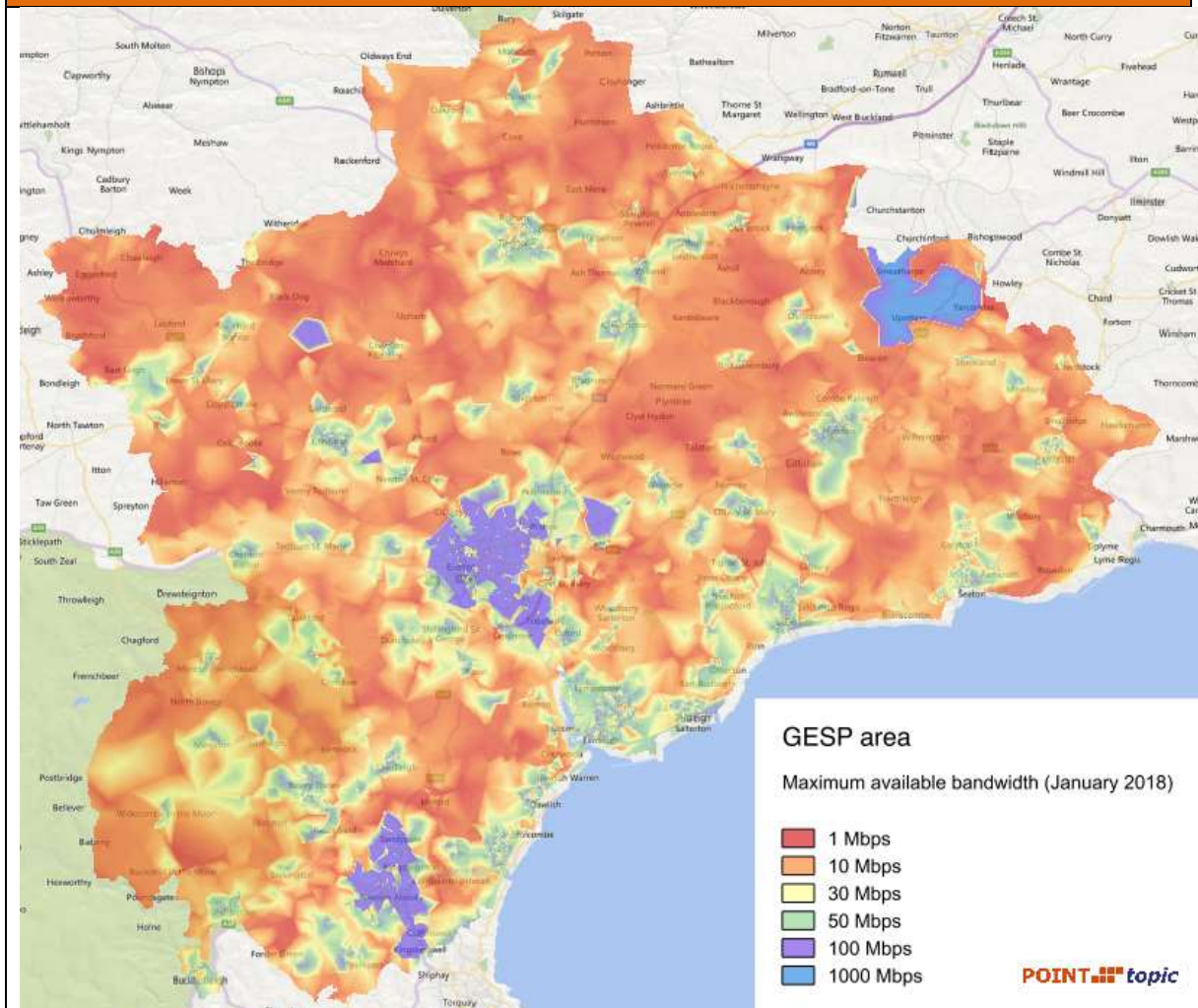


Mapping

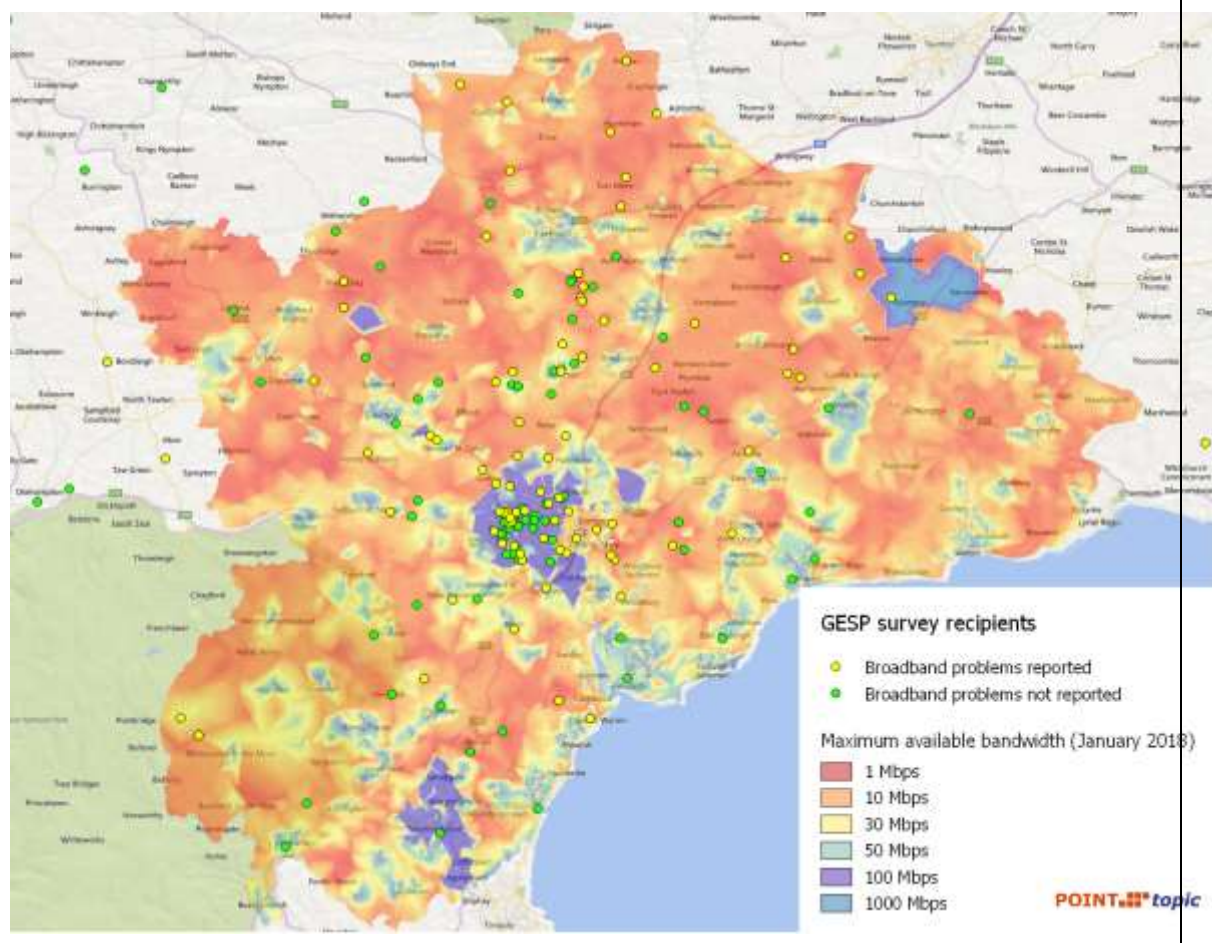
5.14 The following maps show:

- Map 1: Coverage by download speed availability across GE
- Map 2: Overlaying GE SME broadband survey response
- Map 3: Overlaying Non-Domestic Rates data points against connectivity availability
- Map 4: Overlaying Council Tax data points against connectivity availability
- Map 5: Sub 10 Mbps download speed analysis by postcode
- Map 6: Virgin foot print

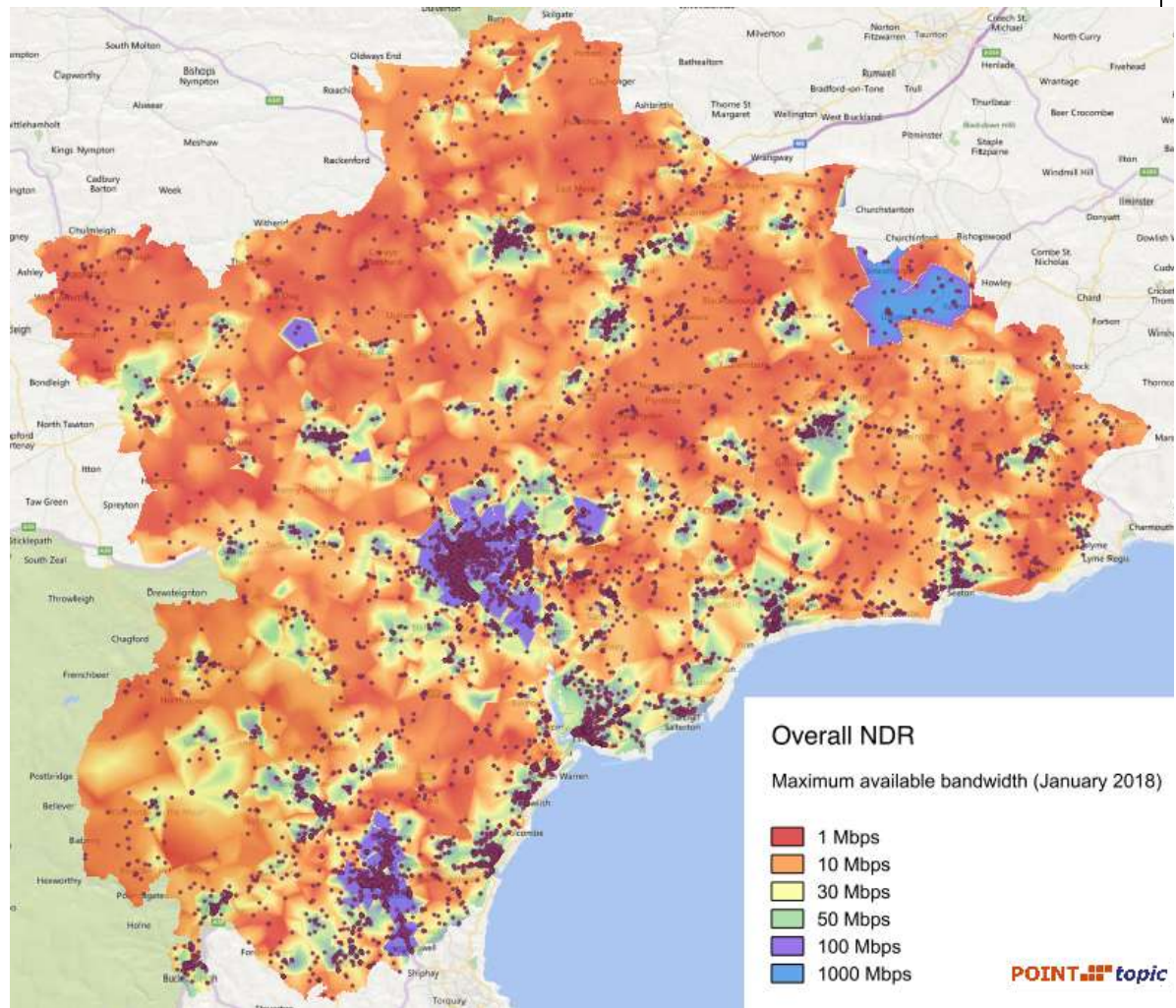
Map 1: Coverage by download speed across GE and survey responses



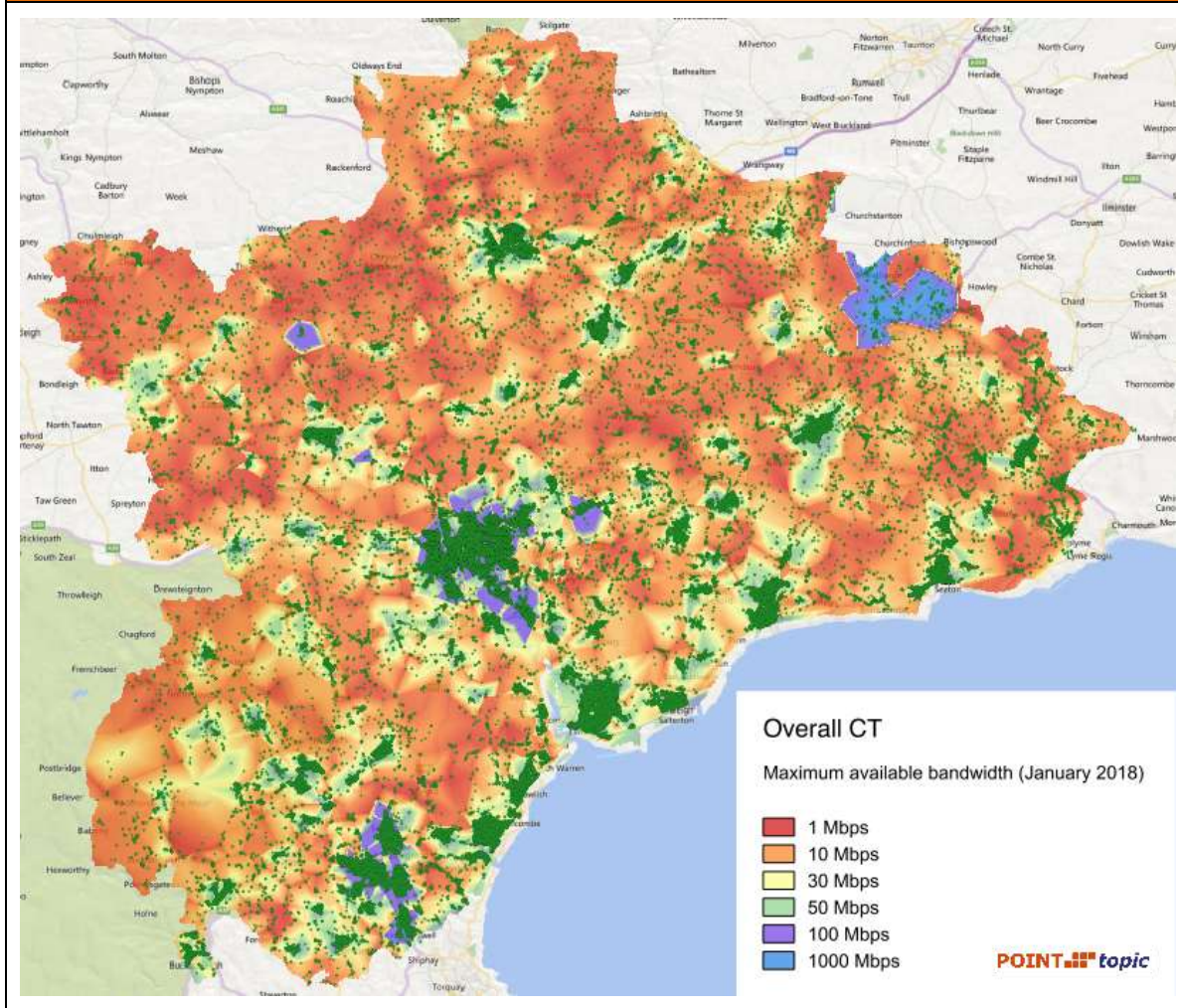
Map 2: Overlaying the GE SME survey results



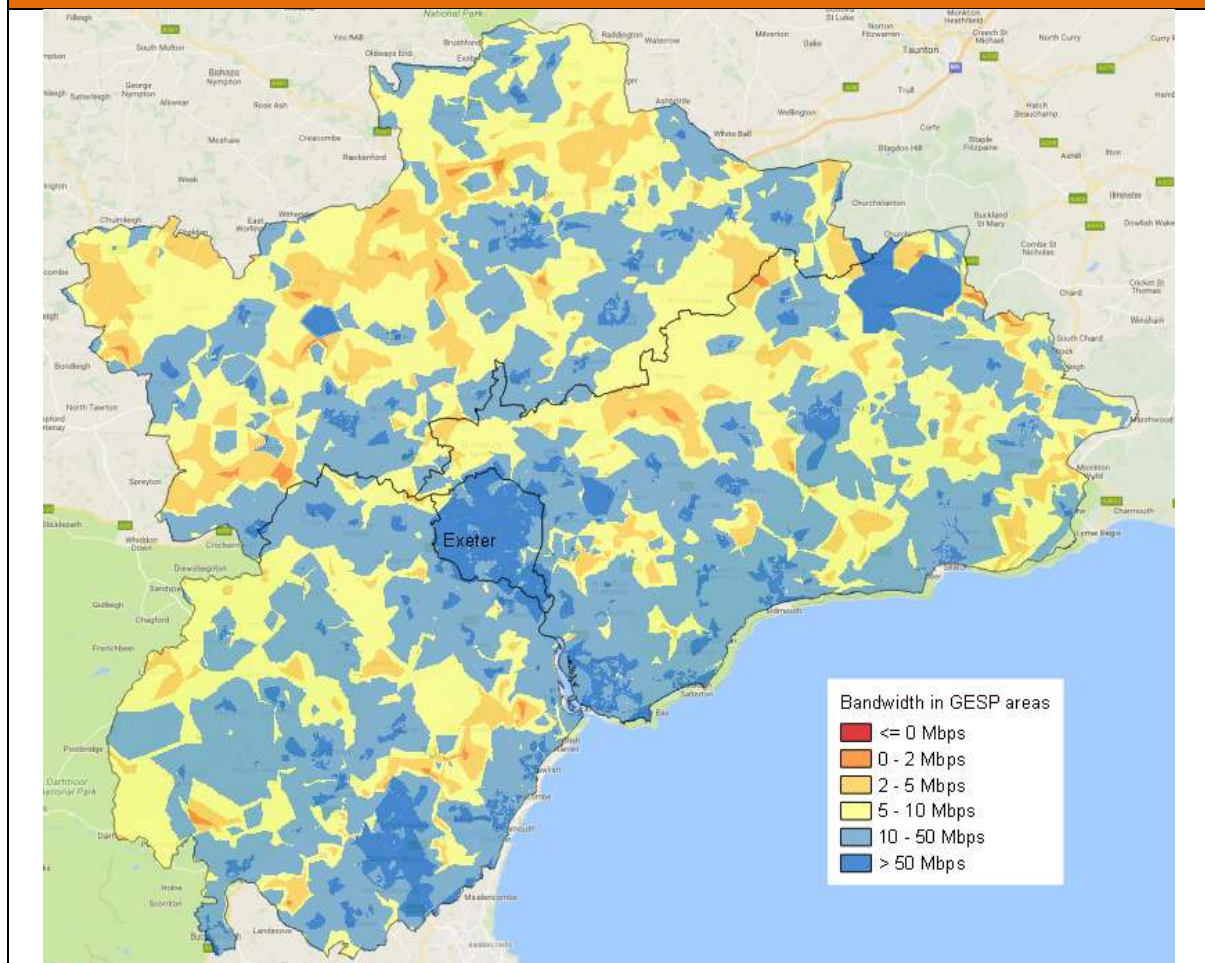
Map 3: Overlaying NDR data points against connectivity availability



Map 4: Overlaying CT data points against connectivity availability



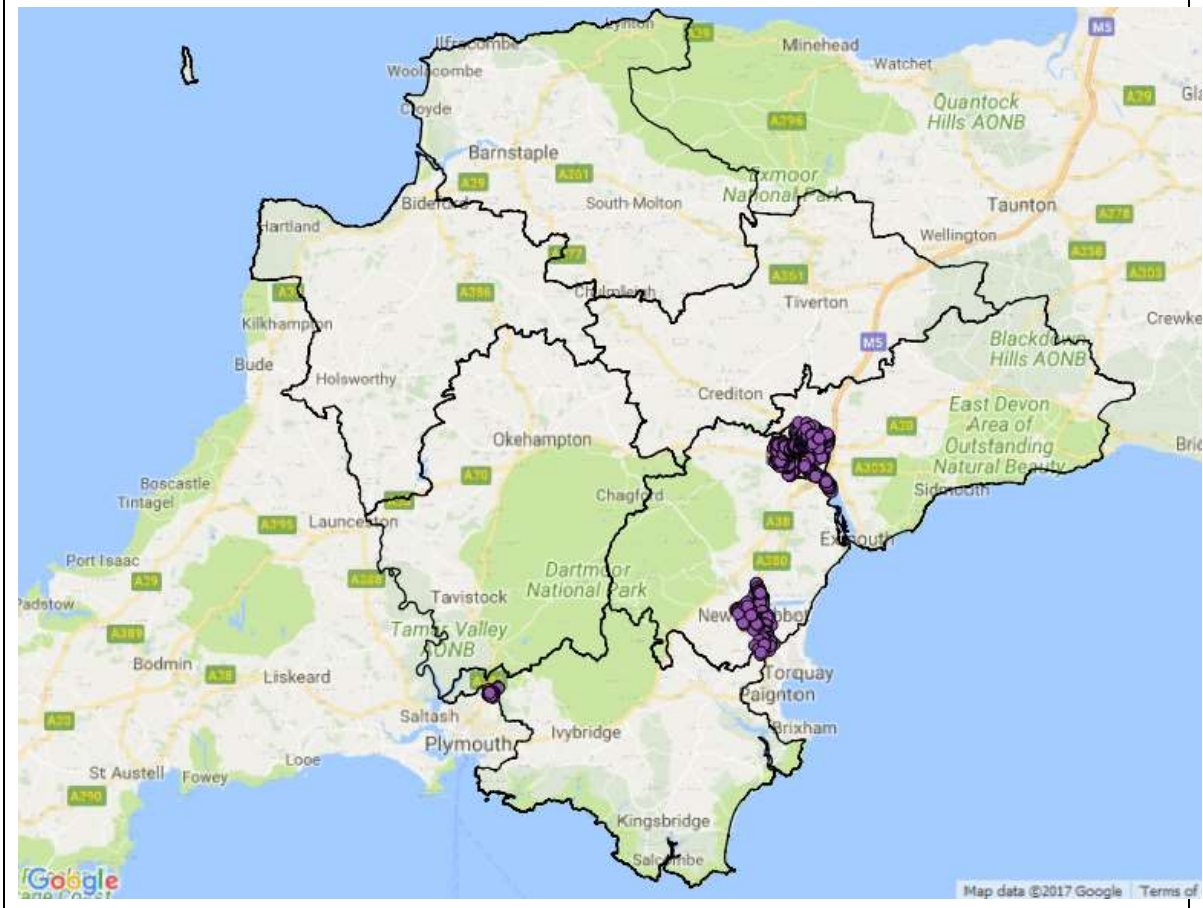
Map 5: Sub 10 Mbps download speed analysis by postcode



Virgin's footprint

- 5.15 Virgin's commercial offer covers 11% (3,283) post codes in Devon, with concentrations in Exeter and Newton Abbot (see map below).

Map 6: Virgin Coverage (Point Topic)



7. Mapping and gapping – future consumer deployment

- 7.1 This section looks at likely future investment in fixed (as opposed to mobile³⁰) digital infrastructure to provide consumer connectivity services nationally, and within this context, across GE, by the established incumbents (BT and Virgin Media) and by the new breed of fast growing companies (often termed altnets). It concludes that gaps at all three service levels (as defined by Ofcom) - standard, super and ultra-fast broadband - are likely to remain across GE, thus justifying the need for a pro-active GE digital strategy.

Summary – consumer broadband - future investment and deployment

We expect there to be significant investment in, and deployment of, additional network infrastructure addressing gaps and growing demand across all three types of broadband (Ofcom's definition) nationally and in the Southwest (including in the GESP area):

- **standard broadband:** (download speeds of up to 30 Mbit/s) – tail end and additional CDS programmes; introduction of a 10 Mbps standard USO; ad hoc community initiatives (including in partnership with the incumbents)
- **superfast broadband:** (download speeds from 30 Mbit/s up to 300 Mbit/s) – BT's rollout of G-Fast, Virgin Media rollout
- **ultrafast broadband:** (download speeds of 300 Mbit/s moving towards Gigabit connectivity) – BT's G-Fast and FttP programmes; Virgin's Lightning Speed programme; investment by one or more altnets (City Fibre et al). Currently Greater Exeter has limited investment by three altnets - Gigaclear, IFNL and CityFibre/third party network are in Exeter and East Devon (via an earlier purchase of kcom network).

Drivers of future consumer broadband investment and rollout will be

- Significant change in national policy, refocussing from gap funding super-fast to pump priming ultra-fast (particularly local full fibre networks)
- Further changes to the regulatory environment making it easier for other service providers to invest in new infrastructure alongside BT and Virgin and to share the incumbents' infrastructure
- Rapid emergence and growth of a cluster of increasingly well-funded new entrants often termed the altnets
- New sources of funding for digital infrastructure from the capital markets which now see investment in infrastructure as a safe long-term play rather than a risky short-term bet

However, we anticipate that major gaps at all three service levels will remain, requiring and justifying a pro-active local GE digital connectivity strategy, that implements best practice interventions and that optimises Government, National Infrastructure Commission and institutional funding as it becomes available

- **Regarding basic broadband** - it is not clear to what extent, how quickly and how effectively the 10 Mbps USO proposals will be implemented
- **Regarding superfast** – CDS report significant lags/shortfalls/ difficulties in implementation of the BDUK gap funded FttC rollout and although additional funding is being made available, it is not clear to what extent and how quickly rollout will be achieved;
- **Regarding ultra-fast** – although this is the new national policy mantra, all acknowledge that extensive investment in local access fibre network is a massive job which will take time; moreover, the policy approach remains similar to the superfast approach, hence it is reasonable to assume that significant gaps/disparities/ connectivity inequality will remain a feature of Britain's digital connectivity landscape.

Conclusions

³⁰ Mobile coverage, gaps, issues and solutions for GE are considered further on

The key messages to draw from this are:

- Whilst the two incumbents, BT (Open Reach) and Virgin Media, are undertaking major investment programmes, it is not clear how fast and to what extent a broadband USO service will be ensured across GE. Neither is it clear to what extent current remaining NGA gaps will be filled and to what extent and how quickly ultra-fast services will become available, through investment in local full fibre networks and services
- This provides the justification for a pro-active GE digital strategy. The scope of a possible GE digital strategy is set out further on, of which a key theme is almost certainly going to involve working with one or more of the altnets, in addition to the incumbents

Drivers of future consumer fixed broadband investment and rollout

7.2 Drivers of investment and fixed rollout will include:

- Significant change in national policy, shifting emphasis from gap funding BT's ultra-fast FttC programme, to a focus on 'full fibre', driven partly by Brexit and the Industrial Strategy; coupled with a realisation that the UK only has 2% full fibre and is falling behind many other countries.
- This policy shift is supported by a number of current Ofcom reviews/ consultations which are designed to make it easier for other suppliers to invest in new fibre network alongside BT and Virgin; and which are also designed to make it easier for other suppliers to use/share BT's infrastructure (poles and ducts). Ofcom's expressed view is that it wants to see competing investment in fibre infrastructure by new players.
- Rapid emergence and growth of 'new entrants' (altnets) with new business models, deploying competitive FttP infrastructure and services
- Acceptance by the capital markets that telecoms infrastructure is no longer a short term high risk investment but, like other infrastructure, can be seen as a more secure, lower risk, long term investment. The establishment of the National Infrastructure Commission (NIC) by the UK Government, coupled with launching of several full fibre infrastructure funds (managed by leading capital market players) has helped reinforce this view, with the altnets now attracting significant long-term infrastructure funding from the US as elsewhere

7.3 Overall, we can expect significant connectivity gaps and inequality to remain, certainly in the short to medium term:

- Regarding basic broadband - it is not clear to what extent, how quickly and how effectively the 10 Mbps USO proposals will be implemented – it is likely that those currently on the very edge of broadband networks will remain excluded unless they take matters in their own hands by implementing one of the various community initiatives;
- Regarding superfast – CDS report significant lags/shortfalls/ difficulties in implementation of the BDUK gap funded FttC rollout and although additional funding is being made available, it is not clear to what extent and how quickly rollout will be achieved;
- Regarding ultra-fast – although this is the new national policy mantra, all acknowledge that extensive investment in local access fibre network is a massive job which will take time; moreover, the policy approach remains similar to the superfast approach, hence it is reasonable to assume that significant gaps/disparities/ connectivity inequality will remain a feature of Britain's digital connectivity landscape.

- 7.4 Of particular note, the vast majority of the above investment is/will be focus on residential, much of it on new-build only rather than retrofit.
- 7.5 Businesses, industrial estates, trading estates, town centres and other business clusters, many of which have been bypassed by FttC rollout as they are not considered to be commercially attractive for investment by the private sector, are left to purchasing bespoke lease line or to put up with poor consumer broadband. The principal national programme that has focussed on business connectivity is the national voucher scheme and the proposed new gigabit-capable voucher scheme under the Local Full Fibre Networks programme.
- 7.6 The superfast job is not done, and the new ultrafast job is massive and just starting. This would suggest that LEPs, local authorities and other local stakeholders can have a significant and important role to play in encouraging, enabling, supporting and facilitating investment, particularly regarding the new ultrafast full fibre mission.

Further detail of forecast fixed rollout

- 7.7 In the remainder of this section we report on likely future investment in consumer broadband services, by operator: Open Reach, Virgin Media, and the fast-evolving new entrants/ start-ups cluster of firms, often termed the altnets – and by technology/ investment programme type (G-Fast, Project Lightning, LFFN)

BT (Open Reach)

BT – universal service obligation

- 7.8 A USO (Universal Service Obligation) for telephony (voice) has been in operation since the GPO was first privatised. The UK, similar to most other advanced industrial countries, is now in the process of putting in place a digital connectivity (broadband) USO
- 7.9 Initially a download speed of 30 Mbps was discussed. The Digital Economy Act approved on 27 April 2017³¹ however rejected a national minimum connection speed of 30 Mbps, settling instead for a 10Mbps minimum. (This despite the fact that, as recently as February 2017, the House of Lords³² declared 10Mbps ‘unfit for usage in a very short time’.) This was seen to be expedient in context of approving legislation during the last sitting of Parliament before the election
- 7.10 Discussions regarding both funding and delivery/procurement arrangements for the broadband USO are under way.
- 7.11 BT is likely to play a key, if not the key role in delivery of the new digital USO, not least because of the ubiquity of its local access network
- On 31 July 2017 the UK Government announced that it had received a voluntary offer from BT Group to meet its universal broadband ambitions – the majority of which would be delivered by Openreach. Point Topic report that according to BT Chief Executive Gavin Patterson, the voluntary offer to deliver the Government’s goal for universal broadband access at minimum speeds of 10Mbps would involve an estimated investment of £450 million to £600 million depending on the final technology solution.
 - Also launched on 11 May 2017 was Openreach’s consultation with communications providers on the next steps for Long Reach VDSL,³³ proven to increase broadband speeds over long phone lines

³¹ Digital Economy Act 2017 <https://services.parliament.uk/bills/2016-17/digitaleconomy.html>

³² Hansard

³³ A major weakness of the Fibre to the Cabinet (FTTC) technology that BT is currently deploying for superfast broadband is that speeds are dependent upon the distance of the copper cable that runs between the street cabinet and business

connected to fibre cabinets. Openreach says the technology could help to deliver universal broadband coverage in line with the Government's policy objectives – set out in the Digital Economy Act. The Government's Universal Service Obligation (USO) proposal gives people the right to request 10Mbps minimum broadband speeds as a right that will be introduced by 2020.

- At the time of writing the Government had yet to accept the offer and had launched a consultation on introducing a legal right to request such speeds. BT is aiming to get 99 per cent of the UK connected to 10Mbps by either December 2021 or December 2022, depending on the mix of technologies used, some of which are subject to trial and industry consultation.

BT – FttP

- 7.12 According to the Government's national statistics published by the Department for Communities and Local Government,³⁴ the number of new dwellings built totalled 147,960 in the year to March 2017, an increase of six per cent compared with the previous year.
- 7.13 Point Topic report that launched in February 2016, the BT FttP scheme:
- Initially offered free FTTP infrastructure for developments of 250 homes or more
 - Then in May 2016 Openreach reduced the threshold to 100 homes, and
 - From November 2016 it was reduced further to 30 homes.
- 7.14 Construction of FTTP infrastructure (the ducting, poles and wires) is carried out for free on such developments of more than 30 premises. Standard connection and ongoing service provider charges apply, and excess construction charges continue to apply where the site is more than 4.5km from Openreach's existing fibre network.
- 7.15 On 24 July 2017 Openreach announced that more than 586,000 premises across 2,400 developments were registered with it nationwide, and that it expected more over the coming months³⁵. There were a reported 235,000 plots registered for FTTP at the end of July 2017.

BT and G-Fast v FttP

- 7.16 BT is generally recognised to have sought to focus investment in its legacy copper telephone network to provide rapid rollout of consumer broadband services. It has done a remarkable job, bringing consumer broadband services to large numbers of households and many businesses, supporting faster and faster headline download speeds, relatively quickly and at relatively low cost (certainly compared with full fibre investment). New copper transmission technologies coupled with investing in bringing fibre deeper into the local network have enabled faster and faster services – from 0.5 Mbps in the early 2000s, rising to 2 Mbps, now up to 50 to 70 Mbps (or more).
- 7.17 Successive rounds of investment have brought fibre deeper into the network and thereby reduced the amount/ length of copper in the network. The reason for reducing the amount of copper in the network

premises and homes. The FTTC technology currently used by BT is called VDSL2. Premises situated within a few hundred metres of a street cabinet may be able to achieve download speeds close to the maximum possible (80 Mbps today). However, those situated more than 1.5 km away may achieve significantly lower speeds. To help address the substantial speed drop-off from conventional VDSL2, BT is running a technical trial of so-called Long Reach VDSL (LR-VDSL) in several exchange areas. This trial commenced in August 2016. The technology is aimed at delivering higher download speeds than VDSL2 for distances in excess of about 1.5 km from the street cabinet.

³⁴ <https://www.gov.uk/government/statistical-data-sets/live-figures-on-house-building>

³⁵ <https://www.ispreview.co.uk/index.php/2017/11/q3-2017-uk-gov-extend-superfast-broadband-4-65-million-premises.html>

is that due to physics³⁶, bandwidth degrades over distance, so the shorter the copper loop, the less degradation

- Initial rounds of investment brought fibre to local exchanges – these programmes were generically known as exchange enablement.
- The next and current round of investment has focussed on bringing fibre to cabinets from the exchange, thus reducing the length of copper in the loop substantially – this programme is generically known as FttC. Customers close to enabled cabinets can benefit from relatively high download bandwidths

7.18 Many thought the only next step was to remove the final length of copper from the network and deploy fibre all the way to the premises. Thus, the local full fibre network programme. The Government has been increasingly pressing BT to do this, but the cost is substantial. BT has run a number of FttP pilot projects, most notably on new developments rather than retrofit

7.19 BT has however not given up on leveraging its copper network further still. A relatively new technology – termed G-fast- represents the next level of technology designed to enable delivery of higher and higher bandwidths over the copper network.

- G-fast can deliver between 150 Mbps to 1 Gbps over a copper loop length of 500m, with the latter speeds only deliverable over a very short loop length.
- BT plans substantial deployment of G-fast over the next 5 years or so
- Some argue that G-Fast is very nearly as good as FttP, others argue that it's not, that services will be highly contested, and that extreme distance sensitivity means that not all premises can benefit

G-Fast – some technical details

- G. Fast is a digital subscriber line (DSL) protocol standard for local loops shorter than 500m, with performance targets between 150 Mbit/s and 1 Gbit/s, depending on loop length.
- High speeds are only achieved over very short loops.
- Although G. Fast was initially designed for loops shorter than 250 meters, Skipio in early 2015 demonstrated G. Fast delivering speeds over 100 Mbit/s nearly 500 meters and the EU announced a research project.
 - ⇒ In tests performed in July 2013 by Alcatel-Lucent and Telekom Austria using prototype equipment, aggregate (sum of uplink and downlink) data rates of 1.1 Gbit/s were achieved at a distance of 70m and 800 Mbit/s at a distance of 100m, in laboratory conditions with a single line.
 - ⇒ On older, unshielded cable, aggregate data rates of 500 Mbit/s were achieved at 100 m.
- The Broadband Forum is investigating architectural aspects of G. Fast and has, as of May 2014, identified 23 use cases.

Deployment scenarios involving G. Fast bring fibre closer to the customer than traditional VDSL2 FTTN (fibre to the node), but not quite to the customer premises as in FTTH (fibre to the home).

- The term FTTdp (fibre to the distribution point) is commonly associated with G. Fast, similar to how FTTN is associated with VDSL2.

³⁶ The volume of bandwidth decreases exponentially in relation to distance when transmitted over copper network. See the following further detail - <https://www.increasebroadbandspeed.co.uk/2012/graph-ADSL-speed-versus-distance>

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Forecast G-Fast deployments in GE

- ## Virgin Media

- ## Virgin Media upgrading superfast capacity

- ³⁷ Data Over Cable Service Interface Specification (DOCSIS /'dɒksɪs/) is an international telecommunications standard that permits the addition of high-bandwidth data transfer to an existing cable TV (CATV) system. It is employed by many cable television operators to provide Internet access (see cable Internet) over their existing hybrid fibre-coaxial (HFC) infrastructure. The version numbers are sometimes prefixed with simply "D" instead of "DOCSIS" (e.g. D3 for DOCSIS 3)

- 7.25 Regarding business broadband, Virgin Media has seen conversion of residential subscribers to its SOHO³⁸ bundles which delivered strong B2B³⁹ revenue growth during Q2 2017. The UK SOHO customer base has doubled year-on-year and SOHO RGUs⁴⁰ increased 151 per cent in the quarter while ARPU⁴¹ from SOHO was also up strongly year-on-year with customers subscribing to additional services. In May 2017 the operator launched a 350Mbps broadband package for SOHO and SME customers. This followed the announcement on 22 March 2017 that Virgin Media would offer ultrafast speeds of 100Mbps and above as standard as it revamped its bundles and launched the Virgin 'fibre' brand, reaching up to 300Mbps for residents and download speeds of 350Mbps for small businesses. Its VIVID broadband products start with VIVID 100 at 100Mbps download and 6Mbps upload, extending to VIVID 300 with 300Mbps download and 20Mbps upload.
- 7.26 Additions to its footprint via Project Lightning are said to be proving positive. The operator no longer provides a timeline for expected build but still intends to complete its footprint expansion covering up to four million premises.

Project Lightning deployment approaches 800,000

- 7.27 The predominantly cable operator said it had added 127,000 Project Lightning premises during Q2 2017 with cumulative build since launch totalling 796,000. The £3 billion Project Lightning was unveiled on 13 February 2015 and aims to extend the Virgin Media network by four million to 17 million premises in the UK by the end of 2019.
- 7.28 Build had been progressing well, however, it emerged in late March 2017 that numbers has been revised down. Liberty Global said Virgin Media had exaggerated how fast it could complete the connections, and that in late February 2017, it had discovered that "the construction work necessary to connect a substantial number of [these premises] had not progressed as originally understood". This prompted the parent company to carry out a review, in which it found "the completion status" of some premises had been "misrepresented". Consequently, what was a build figure of 718,000 was revised down to 567,000 and four staff suspended with disciplinary action.
- 7.29 The company has concluded that in many cases large scale builds deploying narrow trenching to install FTTP are more cost efficient than smaller infill opportunities and as a result Virgin Media has increased its targeted FTTP build from 25 per cent to 50 per cent of the planned four million premises target, without changing the overall costs of the programme.
- 7.30 The probable implications of this for GE are as follows:
- An increase from 25 to 50% FTTP via lower cost micro-trenching will mean deployment of more /better backhaul capacity for VM
 - But, although labelled 'FTTP', the term is probably used in this context to refer to extending VM's existing local access residential cable TV network which is based on DOCSIS technology, rather than on full fibre. DOCSIS is short for 'Data Over Cable Service Interface Specification. DOCSIS is a telecommunications standard used to provide Internet access via a cable modem. The most visible difference to users is that DOCSIS 3.0 modems provide the highest possible service speeds.
 - Extending VM's backhaul network will probably however bring more businesses within its footprint thus allowing VM to offer more businesses lease line services at lower connection cost

³⁸ SOHO stands for Single Owner Home Office

³⁹ Business to Business

⁴⁰ Small office/home office – revenue generating unit

⁴¹ Average revenue per unit

- 7.31 Point Topic also note that that Virgin Media's approach to FTTP is to deploy fibre-optic lines alongside Radio Frequency over Glass (RfOG) which makes it compatible with the company's Docsis cable network, with the aim of offering the same speeds in FTTP areas as over the rest of its network. Presumably this means lower upload speeds than those available on BT's GPON⁴² and some alternative operators' point-to-point networks.

Virgin - Voom Fibre launch

- 7.32 On 20 April 2017 Virgin Media announced the launch of Voom Fibre, saying that from 2 May 2017 new and existing business customers would be eligible to receive ultrafast download speeds of up to 350Mbps as standard, and would be able to choose a range of additional options to suit their needs including increased upload speeds and support options. There are three price plans and upload speeds, with a number of bolt-ons and discounts on additional services.
- 7.33 Virgin Media is ramping up its start-up business marketing with its Voom Tour 2017. The tour is visiting regional centres across the UK and Ireland and will include 10 Voom Pitch competition stops, introduction to Voom Fibre and business networking opportunities. Virgin Media Business is working with partners JCDecaux, ICAEW, Crowdfunder and Virgin StartUp on the tour, with representatives from these organisations available to answer questions from would-be entrepreneurs.

Conclusions

- 7.34 The key messages to draw from this are:
- Whilst the two incumbents, BT (Open Reach) and Virgin Media, are undertaking major investment programmes, it is not clear how fast and to what extent a broadband USO service will be ensured across GE, to what extent current remaining NGA gaps will be filled and to what extent and how quickly ultra-fast services will become available, through investment in local full fibre networks and services
 - A growing number of new entrants (often new start-ups), termed *altnets* are securing investment capital and doing a variety of deals with local authorities and others to rollout significant local full fibre and other forms of ultra-fast networks. It is very likely that GE will need to increasingly engage with these to secure in particular, competitive, more comprehensive ultra-fast services.
- 7.35 Appendix J provides background context on the nature, scale and rapid evolution of the altnet sector.

⁴² A passive optical network (PON) is a telecommunications technology used to provide fibre to the end consumer, both domestic and commercial. A PON's distinguishing feature is that it implements a point-to-multipoint architecture, in which unpowered fibre optic splitters are used to enable a single optical fibre to serve multiple end-points. The end-points are often individual customers, rather than commercial. A PON does not have to provision individual fibres between the hub and customer. Passive optical networks are often referred to as the "last mile" between an ISP and customer. GPON stands for a Gigabit PON

8. Demand for future digital connectivity

8.1 This section considers the evidence for future demand/need for digital connectivity, in GE, by its businesses and residents.

Summary – demand for future digital connectivity across GESP

We have reviewed/used five sources of evidence/methods to provide a picture of future demand

Original DCMS voucher scheme - take-up

- 96 vouchers were applied for and 69 were completed
- Average download speeds increased by 17 times (BT), 4 times (Talk Talk), and 18 times (Zen). Virgin original speed data was redacted
- Average upload speeds increased by 204 times (BT), 31 times (Talk Talk), and 72 times (Zen). Virgin original speed data was redacted

Original DCMS voucher scheme – latent demand

- The scheme manager reports that a number of applications involved substantial extra-over costs, above the scheme threshold – these SMEs presumably still want a better service
- The scheme manager also reported that a number of applications were made after the closure of the scheme

GE SME broadband survey

- Most respondents (77%) were unhappy with the current level of service
- Most respondents still not receiving superfast levels of service - 80% were receiving average download speeds of less than 30Mbps; more than 93% had services where the average upload speed was less than 30 Mbps
- Business-grade services, as well as 'speeds', are a priority – respondents, in order of priority wanted (i) quality and stability of connection (ii) faster downloads (iii) faster uploads
- Broadband connectivity is identified as the most important factor in determining future business location (with mobile service connectivity a close second), above proximity to roads, rail, airports; and above access to a skilled workforce
- Respondents anticipated greater productivity and innovation – resulting in an average sales increase of 20% and a similar gain in productivity (derived largely from staff time saving)

Modelling theoretical future connectivity needs of GE SMEs and households

The Broadband Stake Holder group (BSG) had two major modelling studies undertaken, one estimating the future download and upload speeds of different types and sizes of business, the other estimating the future download and upload speeds of different types and sizes of households⁴³. The models estimated future bandwidth needs by 2023 (for households) and by 2025 (for SMEs). Both models were based on detailed bottom-up analysis comprising We have used the core calculations in both models to estimate likely future peak bandwidth needs of SMEs and residents in GE by 2023/25, and then used the results to estimate total bandwidth needs required to support a typical new settlement in GE (see further on for this later analysis).

⁴³ BSG (The Broadband Stakeholder Group) commissioned creation of two detailed bandwidth use/demand models, one for business premises and one for households. The models are available to members. Point Topic, a member of the Adroit Consortium gained access to the models. Both models are constructed to enable estimating of total national bandwidth needs. We have drawn on key input data/ assumptions in both models to create an alternative model, designed to estimate bandwidth needs for individual households, by size (occupancy) and for individual business units, by type (office, logistics, factory, retail) and by size (employment)

For GE SMEs, we estimate that:

- An employee in a low-media user firm is estimated to require 44/39 Mbps download/upload capacity at peak (assuming they are undertaking all online types of activity all at once)
- An employee in a high media user firm is estimated to require 54/44 Mbps download/upload capacity at peak.

Bandwidth needs per firm are then calculated by multiplying employee bandwidth need by number of employees – we have modelled four sizes of SME comprising 3, 5, 10 and 25 employees

- For a semi media using SME, we estimate that five-person office will require 184 Mbps down and 156 Mbps up at 75% of peak

For GE households, we estimate that:

- A 2-bed household is estimated to need 19/8 Mbps download/upload by 2023 to support 75% of peak activity i.e. occupants are undertaking 75% of all possible online activities at once
- A 4-bed household is estimated to need 24/10 Mbps download/upload by 2023 to support 75% of peak activity⁴⁴

Conclusions

- There is significant dissatisfaction from a number of SMEs regarding current consumer broadband service availability; a proportion have solved their problems through the original voucher scheme but dissatisfaction remains - a number of voucher applicants were excluded from the scheme because they were subject to high connection costs and a number of applications were received for vouchers after the scheme's closing date, suggesting that demand remains for faster better broadband.
- The GE SME broadband survey reflects this dissatisfaction indicating that a number of SMEs want faster more reliable connections and that they anticipate that significant financial and economic benefits will derive from faster better broadband, in terms of increased sales and productivity gains (mainly derived from staff time saving).
- Theoretical modelling of future SME and household bandwidth needs suggests that by 2025, a medium media intensive SME employing 5 will need 184/156 Mbps download/upload capacity to meet 75% peak activity. These speeds and the quality of service required will, in many cases be better met through provision of business grade services, rather than via standard consumer broadband.
- Theoretical modelling of future household bandwidth needs (based on Broadband Stakeholder Group figures), suggests that by 2023, a 2-bed household will need 19/8 Mbps download/upload by 2023 to support (the equivalent of) 75% of peak activity and a 4-bed household will need 38Mbps⁴⁵. This rises to 50 Mbps to support 100% of peak.

Indicators of future demand

- 8.2 Indicators of demand, by businesses, households and new communities, for faster, better, future-proofed digital connectivity include:

⁴⁴ ⁴⁴ When this will impact GE is unclear at the moment. Neither do we know how much this will increase peak bandwidth demand. Sky customers already download a significant element of their content. The addition would be that all live TV/films, usually received via the sky dish, would now be streamed over the customer's broadband connection. At this stage we would suggest adding a 30% multiplier to average residential speeds (consultants approximate estimate)

⁴⁵ These figures take account of the full range of household activities requiring connectivity, including home working.

- Evidence of take up of better/faster broadband services from the voucher scheme (of which, most of the new services were standard consumer services, a small proportion were upgrades to business grade services)
- Evidence of latent and future demand from the voucher scheme i.e. pending applications that were not completed due to time running out; applications that were made after the deadline; applications that were over the cost threshold
- Evidence of latent and future demand from the GE SME survey – 200+ SMEs took part in the survey providing valuable first-hand evidence of demand/need for faster better broadband and the benefits of this
- Modelling theoretical future demand based on the BGS ⁴⁶business connectivity model (i) for different types and sizes of businesses (ii) for different size households
- Modelling need/demand for entire new settlements – fixed, mobile, assisted vehicles, IoT and other smart city functionality

Original SME Voucher scheme take up in Exeter

8.3 As part of Connecting Devon & Somerset's BDUK rollout of plans to ensure 90% superfast coverage by early 2016, a broadband voucher scheme was available in and around Exeter. A total of 96 vouchers were applied for and 69 were completed⁴⁷. Of completions:

- A quarter were provided by BT
- 9% by TalkTalk
- 65% by Virgin and
- 1 by Zen

8.4 Figure 8.1 provides further detail

Figure 8.1: Exeter Voucher		
Applications	No vouchers	Proportion by supplier
BT	23	24%
TalkTalk	7	7%
Virgin	65	68%
Zen	1	1%
Total	96	100%
Completions	No vouchers	Proportion by supplier
BT	17	25%
TalkTalk	6	9%
Virgin	45	65%
Zen	1	1%
Total	69	100%

8.5 Figures 8.2 and 8.3 show previous speeds (average per supplier category, download and upload) and new speeds; Figure 8.4 calculates the speed increase:

⁴⁶ Broadband Stakeholder Group - <http://www.broadbanduk.org/>

⁴⁷ A proportion of applicants did not complete their application. The two most common reasons are that they dropped out of the process (for reasons unknown) or regarding applications submitted towards the end of the programme period, a proportion were still in the application process and hence were not completed by the end date of the programme

Analysis of previous speeds

- Average previous download speeds ranged from 4.5Mbps (BT) to 11.5 Mbps (TalkTalk). Data on Virgin customers original speeds is redacted⁴⁸
- Average previous upload speeds ranged from 0.5Mbps (BT) to 4.8 Mbps (Talk Talk). Data on Virgin customers original speeds is redacted
- Average symmetry ratios range from 0.12 for BT (upload as a proportion of download) to 0.42 (just under 50% symmetry) for TalkTalk

Analysis of new speeds

- Average new download speeds are 78 Mbps (BT), 92 Mbps (Virgin), 57 Mbps (TalkTalk) and 76 Mbps (Zen)
- Average new upload speeds are 25 Mbps (BT), 18 Mbps (TalkTalk), 8 Mbps (Virgin) and 19 Mbps (Zen)
- Average symmetry ratios range from a third (BT and TalkTalk); a quarter (Zen) and 0.09 (Virgin)

Analysis of speed increases

- Average download speeds increased by 17 times (BT), 4 times (Talk Talk), and 18 times (Zen). Virgin original speed data was redacted
- Average upload speeds increased by 204 times (BT), 31 times (Talk Talk), and 72 times (Zen). Virgin original speed data was redacted

Figure 8.2: Previous speeds – completed vouchers

	average previous download speed (Mbps)	average previous upload speed (Mbps)	symmetry ratio (upload /download)
BT	4.5	0.5	0.12
TalkTalk	11.5	4.8	0.42
Virgin	n/a	n/a	n/a
Zen	4.0	1.0	0.25

Figure 8.3: New speeds – completed vouchers

	average new download speed (Mbps)	average new upload speed (Mbps)	symmetry ratio (upload /download)
BT	78	25	0.32
TalkTalk	57	18	0.31
Virgin	92	8	0.09
Zen	76	19	0.25

Figure 8.4: Speed increases

	Average download speed increase	Average upload speed increase ratio	Average upload speed increase	Average upload speed increase ratio
BT	74	17	24	204
TalkTalk	45	4	13	31
Virgin	n/a	n/a	n/a	n/a

⁴⁸ Some of the data was confidential/ under the data protection Act

Zen	72	18	18	72
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8.6 Figure 8.5 shows the average value per voucher

- Just under £300 for BT
- Just under £1,000 for TalkTalk
- Circa £740 for Virgin
- £250 for Zen

Figure 8.5: Average voucher value per supplier	
	Ave voucher value
BT	£289
TalkTalk	£938
Virgin	£738
Zen	£250

Latent demand

8.7 The Exeter voucher scheme manager reports that a number of inquiries/ applications were made that involved substantial extra-over connection work and hence connection costs and these fell outside the scheme's limit. This is anecdotal evidence as opposed to collected statistics, but it does indicate a degree of latent demand for better broadband

8.8 A further indication of latent demand is the number of applications received after the scheme closed. The scheme manager at Exeter reported that:

- "Immediately after the closure of the scheme we were inundated with enquiries, mainly because we'd done a lot of profile raising of the scheme, which then closed 9 months early"
- "Following that, we'd on average receive about one enquiry a week from businesses mainly on Marsh Barton suffering from very poor broadband speeds. Virgin Media fibred up Marsh Barton in the summer of 2016 and BT did Sowton (our other large industrial estate), in the summer of 2017, so enquiries have really reduced since then."
- "We just get the odd city centre one, maybe once a month now."

GE SME broadband survey

8.9 We had 207 responses in total, of which 145 told us about their existing broadband connection. Following are the key results/ conclusions drawn from the survey.

- Most respondents (77%) were unhappy with the current level of service
- 98.5% of respondents are SMEs
 - = 88% are microbusinesses, 81% employing four people or fewer
- Most business owners – 61% - are working from home
 - = A further 12% (25 respondents) are farm-based businesses
- Most respondents still not receiving superfast levels of service
 - = 80% of respondents were receiving average download speeds of less than 30Mbps

- = More than 93% had services where the average upload speed was less than 30 Mbps
- Many respondents not getting what they thought they had paid for
 - = Over a third (34%) of respondents subscribed to services that were advertised as having download speeds of 30Mbps + (a gap between advertised and reported performance of 14%) - meaning that four in every ten subscriptions to 'superfast' or better connections are failing to deliver the promised levels of service.
 - = In 79% of responses, average upload speed was 10Mbps or lower; although 38% reported that their advertised upload speed was 10Mbps+ (a gap between advertised and reported performance in 17% of cases)
 - = Nearly two-thirds (64%) had average upload speeds below 2Mbps; although only 21% reported that this was the advertised upload speed (a gap between advertised and reported performance in 43% of cases)
- Business-grade services, as well as 'speeds', are a priority
 - = In order of importance, those reporting the need for a better broadband service thought that the things that would most influence better business outcomes were:
 - Quality and stability of connection
 - Faster downloads
 - Faster uploads
 - = Suggesting that reliability and service levels are as great a problem as speeds – **and therefore that the type of connection and the SLA** that comes with is as important as advertised throughput.
- Broadband connectivity is identified as the most important factor in determining future business location (with mobile service connectivity a close second)
 - = This ranks connectivity above utilities, roads, rail, airports; and above access to a skilled workforce
- Respondents anticipated greater productivity and innovation
 - = The three outcomes most anticipated from an improved connection were:
 - Improved productivity
 - Reduced costs
 - Increased levels of product/service innovation
 - = 29% anticipated that these benefits would mostly come from time saved; 20% from increases in sales.
- Availability a bigger barrier than cost
 - = Of 76 businesses who attempted to upgrade services, nearly two-thirds (50 out of 76) couldn't access improved services (NGA)
 - = Only 3 reported that the cost was prohibitive – in two cases, due to excessive infrastructure costs; one where increased service charge not deemed worthwhile

- = 2 are still awaiting installation of services ordered using a voucher
- Fewer than a third of those installing superfast broadband or 4G have a satisfactory experience of their new connections
- = Only 7 businesses (of 26) in receipt of an upgrade reported a better service
- = 16 report no improvement or only a marginal improvement
- = 2 report that they upgraded (to 4G) but don't use it because of the monthly cost
- = 1 reports a worse connection!
- = All of which points up the need for business grade services, not NGA or 4G!

Economic impact of faster better broadband – based on analysis of the GE SME broadband survey

- 8.10 The questionnaire was designed to include several questions that enabled us to calculate the financial benefits that respondents believed that would derive from faster better broadband – and from this to then estimate the economic impact of the availability of faster better broadband.
- 8.11 The GE SME broadband survey identifies a range of functional and financial benefits that SMEs anticipate they will derive from access to faster better broadband. We have focussed on two for the purposes of estimating the economic impact of the voucher scheme:
- Sales (turnover) increase (converted to GVA) – average sales increases anticipated by firms to derive from faster better broadband are circa 20%
 - Productivity increase (principally anticipated staff time saving) (monetised as GVA) – average productivity increases anticipated by firms to derive from faster better broadband are circa 20%
- 8.12 Figure 8.6 provides further detail. Sales increase and productivity gains are calculated for three groups of responding firms, based on size (turnover) – all respondents, those with a turnover up to £5m and those with a turnover up to £1m. The uplifts vary depending on size of firm. We have based the analysis on the mid-category – respondents with a turnover up to £5m.

Figure 8.6 GE SME Broadband Survey - analysis			
Sales increase and time saving as a result of better broadband			
Sales increase (as a % current TO)			
	All	SME (up to £5m TO)	Micro (up to £1m TO)
Number analyzed	97	91	82
% increase	13%	20%	20%
Expressed as % of current £ TO	112,345	92,830	51,189
Time savings (as a % current TO)			
	All	SME (up to £5m TO)	Micro (up to £1m TO)
Number analyzed	98	93	83
% saving per employee per year	16%	20%	19%
Expressed as % of current £ TO	153,378	116,462	67,241

Modelling theoretical future demand for connectivity for SMEs and households

- 8.13 The Broadband Stake Holder group (BSG) had two major modelling studies undertaken, one estimating the future download and upload speeds of different types and sizes of business, the other estimating the future download and upload speeds of different types and sizes of households⁴⁹. The models estimated future bandwidth needs by 2023 (for households) and by 2025 (for SMEs). Both models were based on detailed bottom-up analysis comprising:
- Identification of the main types of online activity a typical employee and a typical resident undertakes during the course of a typical day
 - Calculating the bandwidth (download and upload) needed to support each activity
 - Modelling combinations of activity to identify for peak bandwidth needs during a typical day
- 8.14 The models were then used to estimate total national traffic.
- 8.15 We have used the core calculations in both models to estimate likely future peak bandwidth needs of SMEs and residents in GE by 2023/25, and then used the results to estimate total bandwidth needs required to support a typical new settlement in GE (see further on for this later analysis).
- 8.16 There is no reason to presume that behaviour of GE SMEs or residents will differ from the national average, hence we have applied the results from both models without weighting.

Future bandwidth needs of SMEs in GE

- 8.17 Figure 8.7 shows the estimated future bandwidth needs (2025) of different sizes SME (by employment) and different types of SME by degree of media use. The BSG model uses **media use intensity** as a proxy for bandwidth intensity. The BSG model calculates bandwidth needs for both high and low media intensity SMEs; we have added a third category based on the midpoint between these⁵⁰:
- High: Media users
 - Medium: Semi-media users
 - Low: Low/non-media users
- 8.18 The first part of Figure 8.7 shows estimated bandwidth needs per employee:
- An employee in a low-media user firm is estimated to require 44/39 Mbps download/upload capacity at peak (assuming they are undertaking all online types of activity all at once)
 - An employee in a high media user firm is estimated to require 54/44 Mbps download/upload capacity at peak.
- 8.19 Bandwidth needs per firm are then calculated by multiplying employee bandwidth need by number of employees – we have modelled four sizes of SME comprising 3, 5, 10 and 25 employees
- 8.20 Figure 8.7 shows the results of this, for 100% peak and for 75% peak. 75% peak⁵¹ assumes that three quarters of employees are using all possible applications at once. For the purposes of this hypothetical

⁴⁹ BSG (The Broadband Stakeholder Group) commissioned creation of two detailed bandwidth use/demand models, one for business premises and one for households. The models are available to members. Point Topic, a member of the Adroit Consortium gained access to the models. Both models are constructed to enable estimating of total national bandwidth needs. We have drawn on key input data/ assumptions in both models to create an alternative model, designed to estimate bandwidth needs for individual households, by size (occupancy) and for individual business units, by type (office, logistics, factory, retail) and by size (employment)

⁵⁰ The categories, high and low are used in the BSG model. We have calculated a third, a medium, based on the midpoint

⁵¹ 75% is an assumption we have made. We have modelled three such assumptions 100%, 75% and 50% to provide a range of results.

maximum bandwidth demand analysis, we suggest this is a reasonable assumption for maximum likely 'load' at any one time.

- 8.21 From this analysis, we can see that under the medium scenario (i.e. semi-media users), a five-person office will require 184 Mbps down and 156 Mbps up.

Figure 8.7: Peak/max bandwidth per person and per firm (based on employment size)						
2025	Peak/max bandwidth per person assuming they are doing everything at once					
	Download			Upload		
	High	Medium	Low	High	Medium	Low
	54	49	44	44	41.5	39
100%	Peak/max bandwidth assuming every employee is in the office and is doing 100% of everything at once					
No employees	High	Medium	Low	High	Medium	Low
3	162	147	132	132	125	117
5	270	245	220	220	208	195
10	540	490	440	440	415	390
25	1,350	1,225	1,100	1,100	1,038	975
75%	Peak/max bandwidth assuming every employee is in the office and is doing 75% of everything at once					
No employees	High	Medium	Low	High	Medium	Low
3	122	110	99	99	93	88
5	203	184	165	165	156	146
10	405	368	330	330	311	293
25	1,013	919	825	825	778	731

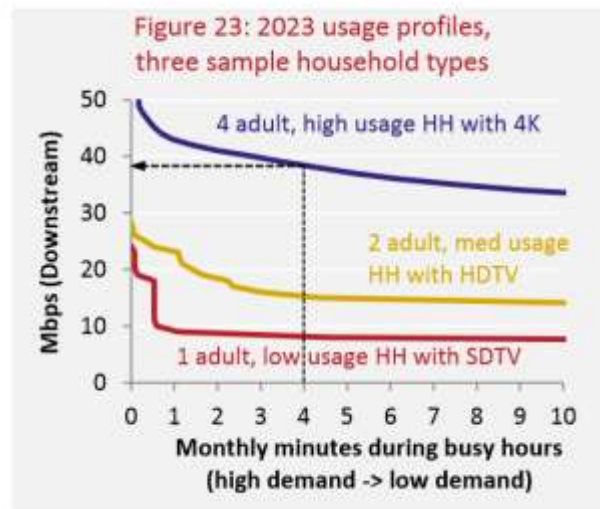
- 8.22 Further details are available on request.

Future bandwidth needs of households in GE

- 8.23 The BSG household bandwidth model adopts a slightly different methodology to that of the SME bandwidth model. The method, approach and detailed results are available from BSG on request⁵². The headline results are shown in figure 8.8

Figure 8.8: Headline results of the BSG residential bandwidth demand model (2023)

⁵² Domestic demand for bandwidth An approach to forecasting requirements for the period 2013-2023
5 November 2013



Source: Robert Kenny & Tom Broughton

Domestic demand for bandwidth An approach to forecasting requirements for the period 2013-2023

5 November 2013

8.24 From this, we have derived the following household bandwidth needs for GE. Figure 8.9 shows the results:

- A 2-bed household is estimated to need 26/10 Mbps download/upload by 2023⁵³ to support the equivalent of 75% of peak activity i.e. occupants are undertaking 75% of all possible online activities at once⁵⁴
- A 4-bed household is estimated to need 33/13 Mbps download/upload by 2023 to support the equivalent of 75% of peak activity.

8.25 Further details of the calculations and assumptions are available on request

Figure 8.9: Estimated bandwidth needs (to support 75% peak needs) of different size households in GE 2023, derived from the residential bandwidth demand model produced for BSG

Bandwidth needs (Mbps) by number of adults (Source BSG report – equivalent of 75% of peak)		
	Download	Upload
4 adult (high usage)	38	15
2 adult (medium usage)	27	11
1 adult (low usage)	25	10
Bandwidth needs (Mbps) by number of beds		

⁵³ We have modelled speed requirements by 2023 because our model is based on the input data to the Broadband Stakeholder Group's model, which models to this date.

⁵⁴ Both the BSG model and our model seek to estimate total bandwidth need then to take only a proportion of that as the realistic functional target. The BSG model is based on a standard telecoms industry demand forecasting methodology defined as 'number of busiest minutes per month excluded' from the calculations i.e. exclusion of peak minutes. Our model uses a different method of exclusion, namely taking only 75% of total bandwidth need where total bandwidth need equates to the bandwidth needed to enable everyone to use all devices/ applications all at once. For modelling purposes, we have assumed that the equivalent of our 75% of peak is similar to the BSG's 4 peak minute per month exclusion as shown by the dotted line in the chart above. Referring to the chart, bandwidth needed to support 100% of peak would be 50 Mbps for a 4-adult household

Household size	Download	Upload
2 bed	26 ⁵⁵	10
3 bed	27 ⁵⁶	11
4 bed	33 ⁵⁷	13

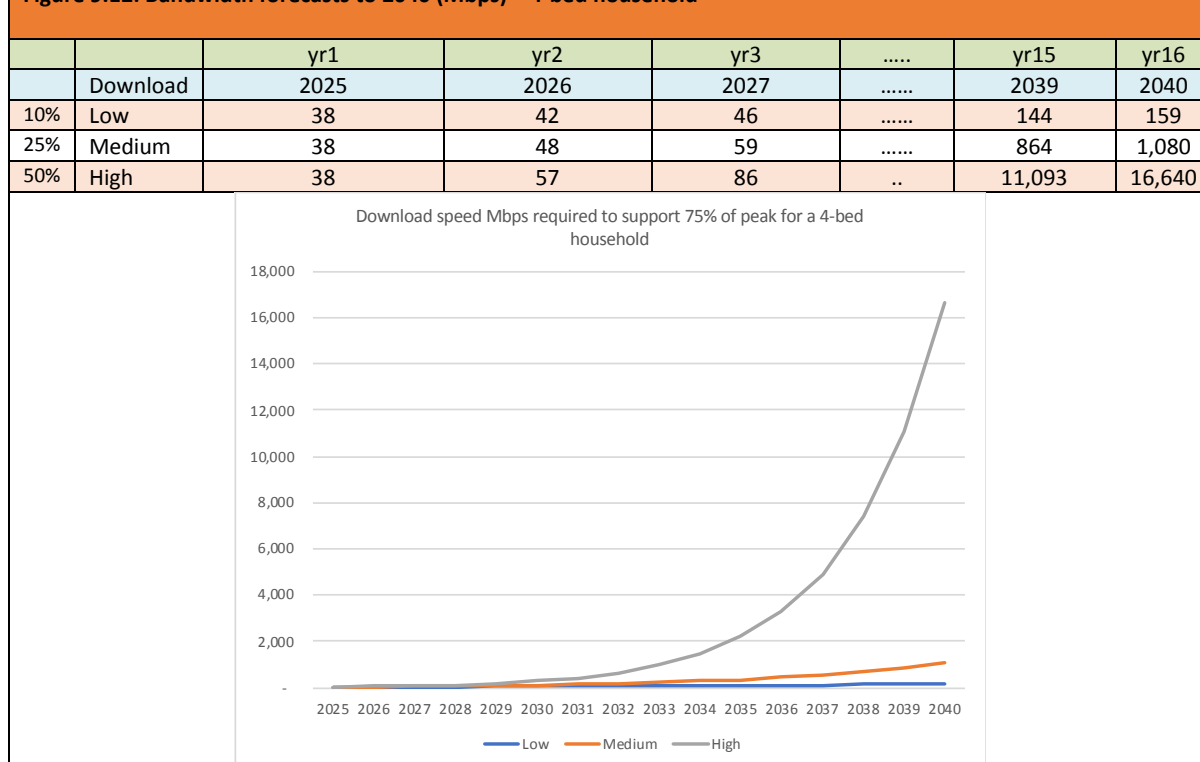
Forecasting bandwidth requirements to 2040

8.26 The above analysis is to 2023/25 in that it's based on the BSG models. We have however prepared three more forward looking bandwidth scenarios, to the year 2040, assuming three annual connectivity demand growth rates⁵⁸:

- 10%
- 25%
- 50%

8.27 Figure 9.12 shows the results

Figure 9.12: Bandwidth forecasts to 2040 (Mbps) – 4-bed household



⁵⁵ Average of 1 and 2 adult household

⁵⁶ 2 adult household

⁵⁷ Average of 2 and 4 adult household

⁵⁸ These annual increase rates have been selected to demonstrate a spread of 'what-if' future outcomes. The low scenario models a small annual increase of 10%, the medium scenario models a mid-range and the high models 50% increase pa (a doubling every 2 years (i.e. Moore's Law). Assuming Moore's Law continues to prevail, this suggests the high scenario as the most likely. 'Moore's Law' is the most cited bandwidth projection model. Tech Explore reports that *In 1965, Gordon Moore, co-founder of Intel, came up with a theory of technology progression that held true for more than 50 years. Coined "Moore's law," the theory suggested that the speed of computer processors would double every two years.*

9. Modelling the connectivity needs of a smart settlement in GE

- 9.1 Our final exercise regarding examination of GE's future connectivity needs, is to pull all of the above analysis and corresponding digital connectivity technologies together, to consider the nature and scale of the digital connectivity needs of a new smart settlement. Whilst at this stage the GESP development strategy has not yet reached such maturity as to know whether there will be any new settlements proposed as part of it, clearly this could be an option. Such a development could potentially have quite different digital connectivity issues, requirements and solutions than expansions to existing settlements, and as such it is prudent to consider these in determining what the correct strategy for GESP should be. The scale of the illustrative example scheme was decided as an easily scalable figure, large enough to deliver a range of different digital needs and uses within it which could therefore test a range of assumptions. The scheme is purely indicative and does not necessarily represent the scale or mix of uses that the GESP or Councils in general might ultimately deem acceptable.

Summary – bandwidth capacity required to support an illustrative new GE settlement comprising 10,000 houses and just under 1,000 business

We have modelled the digital connectivity needs of an illustrative new smart settlement for GE using a high-level model we first developed for the London Borough of Haringey, to model the connectivity needs of major proposals to redevelop the Borough's two key transport hubs, Woodgreen and Tottenham Hale

The illustrative GE scheme comprises 10,000 new homes and B1, B2 and B8 employment space accommodating circa 915 business units, employing circa 7,000 people, plus retail space accommodating circa 40 business units employing 250 people

We have modelled the download and upload capacity requirements for the following types of uses

- Fixed line connectivity
 - == To households – bandwidth needs are based on those reported in the previous section derived from the BSG model
 - == To business premises - bandwidth needs are based on those reported in the previous section derived from the BSG model
- Mobile (5G) /public realm wireless - bandwidth metrics are based on those used in the LBH model
 - == To residents when in their homes - a proportion will still use mobile services in addition to fixed line (inbuilding WiFi) services
 - == To employees when in their place of work – a proportion will still use mobile services in addition to fixed line (inbuilding WiFi) services
 - == To those travelling – on foot, by car, buss, taxi – 5G services
- Smart city/ smart settlement functionality – digital connectivity needs - bandwidth metrics are based on those used in the LBH model
 - == Guided/ assisted vehicles + road transport monitoring and management
 - == IoT⁵⁹ - household appliances, household systems (heating, lighting, power, monitoring, security); business premises appliances, business premises systems (heating, lighting, power, monitoring, security – integrated in building information management platforms (BIM))

Conclusions

⁵⁹ Internet of Things

Total bandwidth capacity requirement of an illustrative new GE settlement comprising 10,000 houses and just under 1,000 businesses, to support 75% of theoretical peak is

- Download – 1.7 Tbps
- Upload – 1.6 Tbps

Suggested network technologies

Three key features are required:

- Capacity (scalable) which suggests fibre optic cable
- Reliability (resilience) – both physical (e.g. more than one feed so that one a JCB accidentally cuts through one feed, traffic is automatically re-routed; and commercial (e.g. avoiding reliance on one commercial supplier at all levels of the supply chain)
- Competition which stimulates innovation, choice and value for money to the customer – which suggests an open access backhaul, settlement ring/spine, and local access network operation, including on-site/in building. Open access operation is where the owner/operator of the physical duct, allows any and all suppliers to pull/blow their own fibre through the duct; which allows any and all suppliers competitive access to the fibre (either dark or lit); which allows any and all suppliers competitive access to the ethernet service delivered over the lit duct. This ensures competition and choice at each and every level of the digital connectivity supply chain (duct, dark fibre, lit fibre)⁶⁰.

Suggested physical architecture

Network resilience is key - because at least half the bandwidth capacity required by the settlement is to support assisted driving, the network needs to offer the highest possible resilience (reliability). We suggest therefore that a similar network architecture is used to those used for other locations that require very high reliability – namely data centres. Data centre network architecture can also be found used in other locations e.g. science parks, business parks. Key features of the architecture are as follows:

- Fibre optic cable throughout – external links (backhaul), settlement rings/spine network and local access network
- Two physically separate feeds to the settlement from two physically separate PoPs⁶¹
- Connecting the settlement at two completed different physical connection points
- Linking into a settlement ring (or rings), off of which local access links are run to connect clusters of buildings

Specification of an illustrative new settlement for GE

9.2 The illustrative scheme comprises:

- Households approx. 10,000 new homes as follows:
 - = 20% 2 beds;
 - = 40% 3 beds;

⁶⁰ These are also the principles which underpin delivery of local full fibre network investment across GE (see further on where we discuss DCMS's proposals for the Local Full Fibre Network programme)

⁶¹ Points of Presence (interconnection points) on existing metropolitan level networks

= 40% 4 beds.

- Employment

= B1, B2 and B8 - Circa 915 business units – employing circa 7,000 people

= Retail – Circa 37 business units employing 250 people

9.3 Figures 9.1 and 9.2 provide a further breakdown

Figure 9.1: Illustrative new settlement for GE - households				
House size	Proportion		Units	Residents (assumes 2.5 persons per dwelling)
2 bed	20%		2,000	5,000
3 bed	40%		4,000	10,000
4 bed	40%		4,000	10,000
Total	100%		10,000	25,000

Figure 9.2: Illustrative new settlement for GE - employment			
Type of employment		No businesses	No employees
B1, B2 , B8		915	7,075
Retail		37	250
Total		952	7,325⁶²

Basis on which we have modelled digital connectivity needs of a new smart settlement for GE

9.4 We have modelled the digital connectivity needs of a new illustrative smart settlement for GE using a high-level model we first developed for the London Borough of Haringey, to model the connectivity needs of major proposals to redevelop the Borough's two key transport hubs, Woodgreen and Tottenham Hale.

9.5 The sequence of steps in the model is as follows:

- Identify digital connectivity uses
- Identify down load and upload speed required (75% of peak) for each use
- Scale this up/ aggregate need/demand at the level of the settlement, based on numbers/ quantum of uses

9.6 The same steps have been applied to an illustrative new settlement for GE.

9.7 It is important to stress that this is intended as an illustrative high-level assessment and does not constitute a proper network planning exercise. Far more detailed mapping, surveying and technical assessment work would be required for a network planning exercise

9.8 The outputs of the model are:

- Estimate of total download and upload capacity required at 75% of peak for all residents, businesses, commuters, and smart city applications

⁶² +/- 20% depending on actual employment densities achieved

- Considerations regarding the likely most suitable digital connectivity technology required to support this
 - Consideration of the procurement/ implementation options
 - Illustrative high level total cost estimates
- 9.9 The model inevitably includes a number of high level assumptions, made by the consultants. Where possible, these are based on proxy metrics. Where no relevant proxy metrics are available, the consultants have made an estimate.
- 9.10 Because of the number of assumptions made, inevitably the results should not be taken as accurate but as a guide, as the centre point of a range of possible outcomes which may vary +/- by 20% at least.

Types of digital connectivity use

- 9.11 We have modelled the download and upload capacity requirements for the following types of uses
- Fixed line connectivity
 - = To households – bandwidth needs are based on those reported in the previous section derived from the BSG model
 - = To business premises - bandwidth needs are based on those reported in the previous section derived from the BSG model
 - Mobile (5G) /public realm wireless - bandwidth metrics are based on those used in the LBH model
 - = To residents when in their homes - a proportion will still use mobile services in addition to fixed line (inbuilding WiFi) services
 - = To employees when in their place of work – a proportion will still use mobile services in addition to fixed line (inbuilding WiFi) services
 - = To those travelling – on foot, by car, bus, taxi – 5G services⁶³
 - Smart city/ smart settlement functionality – digital connectivity needs - bandwidth metrics are based on those used in the LBH model
 - = Guided/ assisted vehicles⁶⁴ + road transport monitoring and management
 - = IoT⁶⁵ - household appliances, household systems (heating, lighting, power, monitoring, security); business premises appliances, business premises systems (heating, lighting, power, monitoring, security – integrated in building information management platforms (BIM))

Fixed-line: Household bandwidth capacity requirements

- 9.12 Total fixed line bandwidth capacity requirements for the settlement's 10,000 households were calculated by:
- Estimating the number of different house sizes (based on number of bedrooms) and associated number of residents

⁶³ For other sites, where other major transport networks (e.g. rail) pass through or close to the site there would need to be an uplift in bandwidth to cater for these additional travelling needs. The same applies for where major road transport corridors pass nearby a site

⁶⁴ See appendix S for further details on connectivity requirements of guided/assisted vehicles

⁶⁵ Internet of Things

- Multiply these by the estimated bandwidth required (at 75%) peak, download and upload, for each size of house – derived from the BSG residential bandwidth model (2023)

9.13 Figure 9.3 shows calculations and assumptions. The model estimates total residential bandwidth capacity needs of:

- Download – 216 Gbps
- Upload – 86.4 Gbps

Figure 9.3: Bandwidth needs of households							
Households – by size	Distribution ⁶⁷	Units	Residents	Capacity per household (75% of peak) ⁶⁶		Capacity for all households	
				Download	Upload	Download	Upload
2 bed	20%	2,000	5,000	19	8	37,500	15,000
3 bed	40%	4,000	10,000	20	8	81,000	32,400
4 bed	40%	4,000	10,000	24	10	97,500	39,000
	100%	10,000	25,000		Total Mbps	216,000	86,400
					Total Gbps	216.0	86.4

9.14 Further details are available on request

Fixed-line: Business premises bandwidth capacity requirements

9.15 Total fixed line bandwidth capacity bandwidth requirements for the settlement's businesses were calculated by :

- Multiplying bandwidth requirements per business by the total number of businesses:
 - = Figure 9.4 shows the estimated bandwidth requirements per business, by sector and by size (employment)
 - = Figure 9.5 shows the results of multiplying business bandwidth needs by the number of businesses in the settlement
- The model estimates total business bandwidth capacity needs of:
 - = Download – 215 Gbps
 - = Upload – 182 Gbps

Figure 9.4: Bandwidth needs of individual businesses, by size sector and by size (employment)								
	Peak/max bandwidth per person and per firm (based on employment size)							
2025	Peak/max bandwidth per person assuming they are doing everything at once ⁶⁸							
	Download				Upload			
	Office/R &D)	Light industrial	Logistics/general industry	Retail	Office/R&D)	Light industrial	Logistics/general industry	Retail
75% of Peak	40.5	36.75	33	13.365	33	31.125	29.25	10.89
	Peak/max bandwidth assuming every employee is in the office and is doing 100% of everything at once							

⁶⁶ Derived from the BSG residential bandwidth model

⁶⁷ Based on data provided by the GESP team

⁶⁸ Based on BSG SME bandwidth needs model

weighting ⁶⁹	No employees	Office/R &D)	Light industrial	Logistics/general industry	Retail	Office/R&D)	Light industrial	Logistics/general industry	Retail
1.0	2	81	74	66	27	66	62	59	22
1.0	5	203	184	165	67	165	156	146	54
1.0	8	324	294	264	107	264	249	234	87
0.8	18	583	529	475	192	475	448	421	157
0.6	35	851	772	693	281	693	654	614	229

Figure 9.5: Total bandwidth needs of employment space

				Download	Upload
	No businesses	No employees		Total Mbps (75% peak)	
Total B1, B2, B8	915 ⁷⁰	7,075 ⁷¹	Mbps	211,861	179,868
			Gbps	211.9	179.9
Total retail	37	250.5	Mbps	2,841	2,315
			Gbps	2.8	2.3
Total	952	7,325	Mbps	214,702	182,183
			Gbps	214.7	182.2

Mobile bandwidth capacity requirements

9.16 Total mobile bandwidth capacity requirements were estimated by:

- Estimating the total number of mobile device users at peak (those using mobile whilst, shoppers, commuters, workers and residents)
- Estimating the proportion of these using the mobile phone network as opposed to in-house WIFI via a fixed line router
- Multiplying net mobile GSM⁷² users by average bandwidth.

9.17 Figure 9.6 shows the calculations and assumptions. The model estimates total mobile bandwidth capacity needs of:

- Download – 27 Gbps
- Upload – 10 Gbps

⁶⁹ The weighting is used to reduce the average bandwidth per employee for larger employers. This has the effect of reducing the 75% peak figure used as the basis for modelling likely total maximum bandwidth capacity requirements. Maximum bandwidth requirements for larger employers is likely to be less than 75% peak. The weighting metrics used are the consultant's assumptions

⁷⁰ Based on detailed breakdown provided by GESP team

⁷¹ Consultant's calculations based on the above

⁷² GSM stands for Global System for Mobile Communications; it's the world's most prolific mobile standard (a standard being a set of rules and suggestions about how a mobile network should work)

Figure 9.6: Mobile bandwidth capacity requirements

					2025 bandwidth need per person Mbps		Download		Upload	
GE - personal connectivity whilst mobile	People	% of using mobile at peak ⁷³	% of users using GPS ⁷⁴ 75	Peak users	Download ⁷⁶	Upload	Total bandwidth Mbps	Total bandwidth Gbps	Total bandwidth Mbps	Total bandwidth Gbps
shoppers	280	75%	100%	210	2.60	0.91	546	0.55	191	0.19
commuters	7,325	75%	100%	5,494	2.60	0.91	14,284	14.28	4,999	5.00
workers	7,325	75%	20%	1,099	2.60	0.91	2,857	2.86	1,000	1.00
residents	25,000	50%	30%	3,750	2.60	0.91	9,750	9.75	3,413	3.41
Total	39,930			10,553			27,437	27.4	9,603	9.6

IoT bandwidth capacity requirements

9.18 Total IoT bandwidth capacity requirements were calculated by:

- Estimating the average number of IoT devices in the settlement per use type – households, business premises and wider city systems
- Multiplying these by the relevant populations
- Multiplying these by an assumed average down/upload bandwidth capacity per device

9.19 Figure 9.7 shows the calculations and assumptions. The model estimates total IoT bandwidth capacity needs of:

- Download/upload – 14.4 Gbps

Figure 9.7: Bandwidth needed to support IoT devices in the proposed new settlement

Device users	Ave no devices ⁷⁷	Population	No devices	Devices	% of devices in use at peak	devices in use at peak	2025 bandwidth need per device Mbps ⁷⁸	Total bandwidth Mbps	Total bandwidth Gbps
per household	20	10,000	200,000		75%	150,000	0.04	6,000	6.0
per business	30	952	28,560		75%	21,420	0.04	857	0.9
wider city systems ⁷⁹	10	25,000	250,000		75%	187,500	0.04	7,500	7.5
Total			478,560	478,560	75%	358,920	0.04	14,357	14.4

Assisted vehicle bandwidth capacity requirements

9.20 Total assisted vehicle bandwidth capacity requirements were calculated by:

⁷³ Consultant's assumption

⁷⁴ as opposed to fixed line router WiFi

⁷⁵ Consultant's assumption

⁷⁶ Derived from the Haringey model

⁷⁷ Consultants working assumption

⁷⁸ Derived from the Haringey model

⁷⁹ based on average number per head population

- Estimating the number of vehicles on the road at peak travel time
- Multiplying this by the average bandwidth requirement per vehicle

9.21 Figure 9.8 shows the calculations and assumptions. The model estimates total assisted vehicle bandwidth capacity needs of:

- Download/upload – 1,440 Gbps

Figure 9.8: Assisted vehicle bandwidth capacity requirements							
		am commutin g	mid- morning	lunch time	mid afternoon	pm commu ting	evening
Number of assisted vehicles	Peak	3,600⁸⁰	3,600	3,600	3,600	3,600	3,600
	% of Peak	100%	30%	50%	30%	100%	40%
	Total vehicles at Peak	3,600	1,080	1,800	1,080	3,600	1,440
Assisted vehicle Mbps	400 ⁸¹	1,440,000	432,000	720,000	432,000	1,440,000	576,000
	Gbps	1,440.0	432.0	720.0	432.0	1,440.0	576.0

Conclusions: total bandwidth capacity requirement of an illustrative new GE settlement comprising 10,000 houses and just under 1,000 businesses

9.22 Figure 9.9 shows the total estimated bandwidth capacity requirement for the illustrative new GE settlement comprising 10,000 houses and just under 1,000 businesses, in 2023/25, at different times of the day. At the busiest time (am commuting and pm commuting times), the total bandwidth capacity requirement is:

- Download – 1.7 Tbps⁸²
- Upload – 1.6 Tbps

Figure 9.9: Total estimated bandwidth capacity requirements for an illustrative new settlement comprising 10,000 houses and just under 1,000 businesses (2023/25)						
Tbps ⁸³	am commuting	mid-morning	lunch time	mid afternoon	pm commuting	evening
Download	1.7	0.8	1.0	0.8	1.7	0.8
Upload	1.6	0.7	0.9	0.7	1.6	0.7

9.23 Figures 9.9 and 9.10 show the calculations

Figure 9.9: Total download capacity requirement						
Download	am commuting	mid-morning	lunch time	mid afternoon	pm commuting	evening

⁸⁰ Estimated peak vehicle movements provided by GESP team. See appendix S for further details on modelling the connectivity needs of assisted/guided vehicles

⁸¹ The Haringey model used 400 Mbps down/upload requirement per vehicle. This was derived from <http://www.computerworld.com/article/2484219/emerging-technology/self-driving-cars-could-create-1gb-of-data-a-second.html>. The article suggests that fully autonomous vehicles require 1Gbps, semi-autonomous require 650 Mbps and that assisted vehicles require 400 Mbps. We have modelled for the lowest level of guidance (namely assisted)

⁸² Terabits per second (1,000 Gbps)

⁸³ Terabits per second (1,000 Gbps)

Fixed line						
B1/B2/B8	42.4	211.9	127.1	211.9	42.4	21.2
Retail/town centre uses	1.4	2.0	2.8	2.0	1.4	0.6
Residential	151.2	108.0	129.6	108.0	151.2	151.2
Mobile/ public space						
shoppers	0.3	0.5	0.5	0.5	0.3	0.1
commuters	11.4	2.9	2.9	2.9	11.4	1.4
workers	0.6	2.3	2.3	2.3	0.6	0.3
residents	5.9	4.9	5.9	4.9	5.9	9.8
Smart city/ IoT						
IoT	14.36	14.36	14.36	14.36	14.36	14.36
vehicles	1,440	432	720	432	1,440	576
GBPS	1,667	779	1,005	779	1,667	775
TBPS	1.7	0.8	1.0	0.8	1.7	0.8

Figure 9.10: Total upload capacity requirement

Upload	am commuting	mid-morning	lunch time	mid afternoon	pm commuting	evening
Fixed line						
B1/B2/B8	36.0	179.9	107.9	179.9	36.0	18.0
Retail/town centre uses	1.2	1.6	2.3	1.6	1.2	0.5
Residential	60.5	43.2	51.8	43.2	60.5	60.5
Mobile/ public space						
shoppers	0.10	0.19	0.19	0.19	0.10	0.02
commuters	4.00	1.00	1.00	1.00	4.00	0.50
workers	0.20	0.80	0.80	0.80	0.20	0.10
residents	2.05	1.71	2.05	1.71	2.05	3.41
Smart city/ IoT						
IoT	14.36	14.36	14.36	14.36	14.36	14.36
vehicles	1,440	432	720	432	1,440	576
GBPS	1,558	675	900	675	1,558	673
TBPS	1.6	0.7	0.9	0.7	1.6	0.7

Expressing total bandwidth capacity required to support a new settlement in terms of average bandwidth per household

9.24 We have divided the number of households (10,000) into the total bandwidth capacity required to support the new settlement, to provide an overall unit connectivity metric.

9.25 Figure 9.11 shows the results:

- Download – 167 Mbps
- Upload – 156 Mbps

Figure 9.11 Mbps required (2023/25) by whole settlement divided by No. households

Download	166.75
Upload	155.83

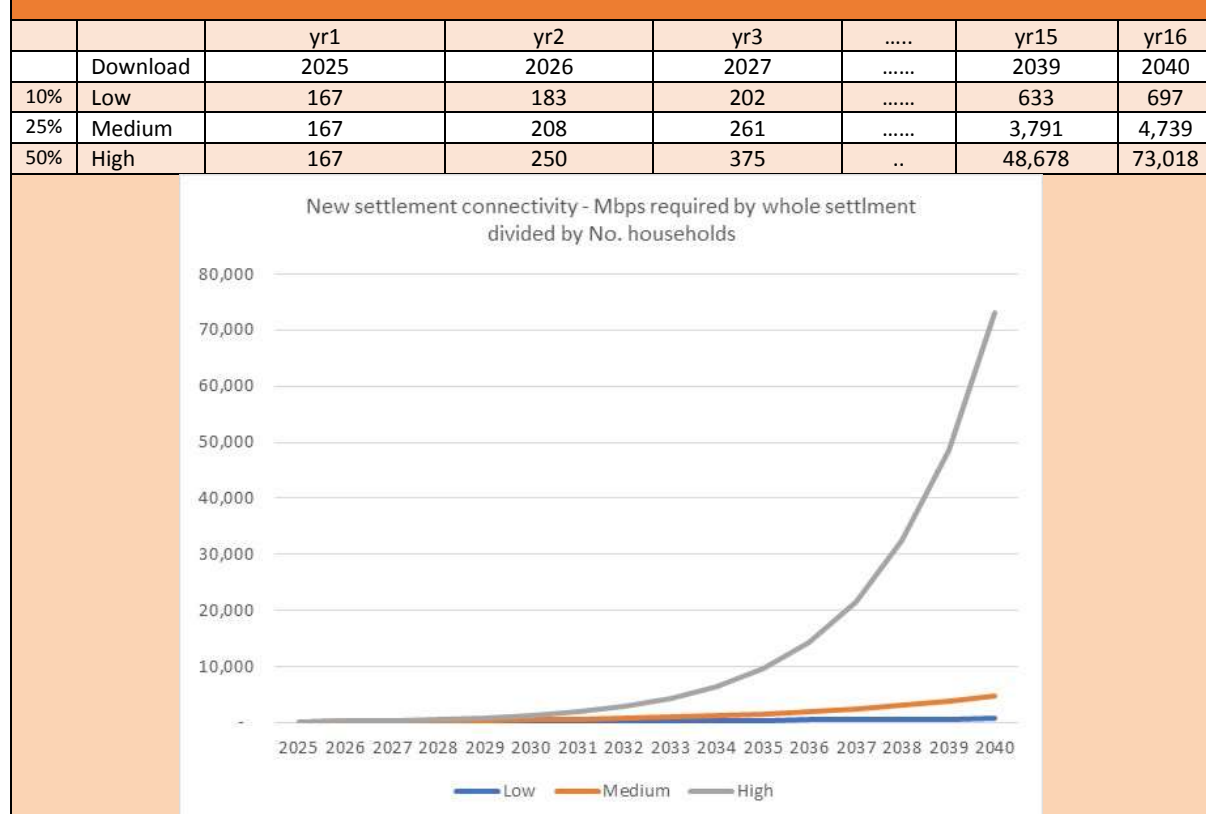
Forecasting bandwidth requirements to 2040

9.26 The above analysis is to 2023/25 in that it's based on the BSG models. We have however prepared three more forward looking bandwidth scenarios, to the year 2040, assuming three annual connectivity demand growth rates⁸⁴:

- 10%
- 25%
- 50%

9.27 Figure 9.12 shows the results

Figure 9.12: Bandwidth forecasts to 2040 (Mbps)



Suggested network technologies

Key features required

9.28 Three key features are required:

⁸⁴ These annual increase rates have been selected to demonstrate a spread of 'what-if' future outcomes. The low scenario models a small annual increase of 10%, the medium scenario models a mid-range and the high models 50% increase pa (a doubling every 2 years) (i.e. Moore's Law)). Assuming Moore's Law continues to prevail, this suggests the high scenario as the most likely. 'Moore's Law' is the most cited bandwidth projection model. Tech Explore reports that in 1965, Gordon Moore, co-founder of Intel, came up with a theory of technology progression that held true for more than 50 years. Coined "Moore's law," the theory suggested that the speed of computer processors would double every two years.

- Capacity (scalable) which suggests fibre optic cable
- Reliability (resilience) – both physical (e.g. more than one feed so that if a JCB accidentally cuts through one feed, traffic is automatically re-routed); and commercial (e.g. avoiding reliance on one commercial supplier at all levels of the supply chain)
- Competition which stimulates innovation, choice and value for money to the customer – which suggests an open access backhaul, settlement ring/spine, and local access network operation, including on-site/in building. Open access operation is where the owner/operator of the physical duct, allows any and all suppliers to pull/blow their own fibre through the duct; which allows any and all suppliers competitive access to the fibre (either dark or lit); which allows any and all suppliers competitive access to the ethernet service delivered over the lit duct. This ensures competition and choice at each and every level of the digital connectivity supply chain (duct, dark fibre, lit fibre)⁸⁵.

Suggested physical architecture

9.29 **Network resilience is key** - because at least half the bandwidth capacity required by the settlement is to support assisted driving, the network needs to offer the highest possible resilience (reliability). We suggest therefore that a similar network architecture is used to those used for other locations that require very high reliability – namely data centres. Data centre network architecture can also be found used in other locations e.g. science parks, business parks. Key features of the architecture are as follows:

- Fibre optic cable throughout – external links (backhaul), settlement rings/spine network and local access network
- Two physically separate feeds to the settlement from two physically separate PoPs⁸⁶
- Connecting the settlement at two completed different physical connection points
- Linking into a settlement ring (or rings), off of which local access links are run to connect clusters of buildings

⁸⁵ These are also the principles which underpin delivery of local full fibre network investment across GE (see further on where we discuss DCMS's proposals for the Local Full Fibre Network programme)

⁸⁶ Points of Presence (interconnection points) on existing metropolitan level networks

10. Mobile and Public Wireless

10.1 This section considers both mobile and wireless technologies and services

- Regarding mobile – this section defines current and future mobile technologies, outlines the Government's current policy and funding opportunities, assesses (as far as the available data permits), current and likely future coverage/ mobile service provision across GE, identifies current (and likely future) gaps and the reported impacts of these, and sets out a suggested approach and action themes to include in the proposed GE digital connectivity strategy
- Regarding wireless – we define what is meant by public wireless, we consider the issues often faced by public WIFI projects, we consider the potential applications of public wireless projects

Summary – mobile coverage, issues and next steps - GESp

4G coverage and gaps

- Mapping of 4G coverage, and hence of 4G coverage gaps in GE, at a sufficiently granular level to be meaningful is not yet possible, because MNOs⁸⁷ are not prepared to release their data because of commercial sensitivity reasons. Ofcom is seeking to address this at present, but at the time of writing, it is unclear to what extent and when this will be achieved
- CDS states that there are 7,000 households in Devon and Somerset with no outdoor 4G coverage; this will translate into a higher number still of premises with no indoor coverage; and a proportion of those with coverage may only be served by a single Mobile Network Operator (MNO), but will still show as having outdoor coverage on Ofcom's maps - so there will be many more consumers whose network does not serve both their home and work address, for instance

5G coverage and gaps

- 5G technology is still not finalised. The Government's 5G strategy anticipates deployment to commence early in the next decade.
- The Government's strategy identifies 5G as a transformational technology, with use-cases and impacts way beyond the way 4G is currently used. 5G will provide very fast higher quality connectivity to smart phones/ Tablets etc, but it is also expected to be embedded in and utilised in smart city and industrial applications
- Key activities at the moment include funding of local pilots – we understand that GE has not applied to any of the current funding rounds
- Successful rollout of 5G is anticipated to require a larger volume of masts, dishes, antenna etc, hence GE will need to ensure that the local planning regime is ready for this
- Successful rollout of 5G is also anticipated to require high capacity backhaul, mainly provided by fibre optic cable. Hence, successful rollout of 5G will require extensive local access fibre network. Thus, 5G rollout will depend in part on how successful GE's Local Full Fibre Network programme of investment is. This is likely to be particularly challenging in rural areas

Actions for GE to consider undertaking

Addressing current 4G coverage gaps, particularly in the rural areas

We identify 4 potential action areas to consider in discussion/ consultation with the MNOs⁸⁸

- Mapping 4G coverage gaps at a sufficiently granular level to be useful – including overlaying with land use maps, public land ownership maps. This depends on how fast Ofcom can get MNOs to share network data

⁸⁷ Mobile network operators

⁸⁸ Mobile network operators

- Further reduction of land use planning obstacles to installation of new masts/towers – GE should explore this now
- Gap funding MNO network rollout – currently prevented by EC State aid regulations, so it's a case of waiting to see if these regulations continue to apply post-Brexit. The current thinking is that they are likely to
- Community action – investment by households and businesses in mobile phone signal repeaters. This is a low-cost way of extending the 4G network. It is subject to regulation however. Ofcom has just completed a review of the regulation and decided to permit use of repeaters by households only, but only within the house, not between properties. So, at present, this option is not available

Preparing the way for 5G deployment, anticipated to take place in the next decade

We identify at two stage 5G strategy for GESP

Taking an active flagship role in helping develop 5G technology and its applications

- Paving the way for 5G rollout, by making GESP more investment ready for 5G
- Taking an active flagship role in helping develop 5G technology and its applications
- Government and intermediary agencies have issued a number of competitive funding rounds focussed on pilot programmes. GESP as far as we are aware has not bid into any of these as yet. It should seek to do so in the next available funding rounds.
- Examples of the types of pilot/demonstrator studies that GESP could seek to pursue include:
 - == 5G and smart settlements - focussing on development proposals which arise through the GESP
 - == 5G and one or several industry-sector applications
 - == 5G and precision agriculture

Taking an active flagship role in helping develop 5G technology and its applications

- Planning - GESP needs to address potential planning hurdles to masts/dish sites - Planning regulations are a key factor influencing a network infrastructure provider's ability to expand its network, as they govern where sites can be built and the physical appearance of the equipment that can be installed on such sites. The deployment of 5G will require a significant increase in the number of small radio cells - likely to be located on street furniture, the sides of buildings etc. - in order to facilitate the requirements of 5G networks. Therefore, flexible and fit for purpose planning regulations will be required to support the deployment of 5G networks.
- Fibre backhaul - actively implement all feasible measures possible to support and enable large scale investment in local full fibre networks across GESP, including in the rural areas

4G – GESP coverage

- 10.2 CDS states that there are 7,000 households in Devon and Somerset with no *outdoor* 4G coverage; this will translate into a higher number still of premises with no indoor coverage.
- 10.3 Data are not currently available from Ofcom, and may not be for some time, in a form to enable us to disaggregate this to arrive at a number for GESP, nor if the impact is uniform across the whole of Devon and Somerset.
- 10.4 Certainly, CDS report a significant volume of complaints about lack of mobile coverage.
- 10.5 The coverage issue is two-fold:
 - Some areas are not covered by any mobile network

- And of those that are, some areas may only be served by a single Mobile Network Operator (MNO), but will still show as having outdoor coverage on Ofcom's maps – so there will be many more consumers whose network does not serve both their home and work address, for instance

National context

- 10.6 UK attempts to address widespread gaps in 2G, 3G and 4G coverage through provision of new mobile infrastructure funded via the Mobile Infrastructure Programme (2012-16) was mostly unsuccessful, as it failed to promote the joint working between mobile network operators (MNOs) needed to ensure that this translated into coverage of 'not-spots'⁸⁹.
- 10.7 BDUK's own attempt to intervene by building infrastructure (MIP) foundered on the unwillingness of operators to share access to masts and equipment.
- 10.8 Government has now changed tack to a regulatory route of requiring better coverage as part of licensing of spectrum for mobile

What can GESP do to address 4G gaps in service coverage

- 10.9 We identify 4 potential action areas to consider in discussion/ consultation with the MNOs⁹⁰
- Mapping 4G coverage gaps at a sufficiently granular level to be useful – including overlaying with land use maps, public land ownership maps
 - Further reduction of land use planning obstacles to installation of new masts/towers
 - Gap funding MNO network rollout
 - Community action – investment by households and businesses in mobile phone signal repeaters
- 10.10 Some can be implemented now, some are dependent on changes in national regulation and some are dependent on the extent to which European Commission regulations (e.g. State aid) continue to apply post-Brexit

Consultation/lobbying of MNOs to encourage more investment to fill 4G gaps

- 10.11 GESP should engage in round table discussions with MNOs to identify the nature and scale of 4G coverage gaps, to discuss what regulatory/administrative barriers can be reduced (e.g. planning permission for masts/towers) and to identify what other assistance MNOs need to enable them to make business cases to extend network coverage
- Identifying the extent and nature of 4G coverage gaps across GE is a critical first step. At present it is not possible to do this. MNOs will not share their data because of confidentiality/commercial sensitivity reasons.
 - Ofcom is in the process of addressing confidentiality around MNO data. The extent of progress and timing of this is unclear at the time of writing, but if/when addressed, local authorities will be able to access sufficiently detailed coverage data to enable them to identify the extent and nature of local mobile phone coverage gaps. This is essential before meaningful discussions can take place with MNOs
 - The experience of engagement with 'fixed mobile' operators (Gigaclear and Airwave) in Phase 2 of CDS's National Broadband scheme suggests that the network operators themselves are likely to welcome both more detailed information on public land ownership (for location of masts) and

⁸⁹ DCMS (2017). Mobile Infrastructure Project Impact and Benefits Report, <https://www.gov.uk/government/publications/mobile-infrastructure-project-impact-and-benefits-report>

⁹⁰ Mobile network operators

community engagement in investment in repeater technology as a way to rationalise and prioritise their commercial investment – but this needs to be confirmed through soft market testing

Opportunities to reduce land use planning obstacles to investment in additional masts and towers

- 10.12 The Government has already introduced planning reforms in England which include a significant relaxation of restrictions on the siting and installation of small cells that will support both 4G (and future 5G) rollout. In particular, it has:
- legislated for additional permitted development rights for taller mobile masts;
 - removed the threshold for placing small cell antenna on commercial buildings and structures to support mobile rollout. This means MNOs can deliver a greater number of small cells to handle greater mobile capacity on their networks for 4G and, subject to how it will operate, 5G;
 - brought into effect new building regulations which require all new buildings and existing buildings undergoing major renovations to have infrastructure capable of delivering superfast broadband greater than 30Mbps.
- 10.13 However, there are still planning constraints on building new masts in GESP – Airband for example has had a negative response to plans to build masts for fixed wireless in some areas – and there may be similar challenges to planning for mobile network infrastructure – including for masts to be erected on publicly-owned land.
- 10.14 GESP should examine scope to further reduce planning obstacles. This will be critical to successful rollout of 5G in the next decade (see further on)

Opportunities to gap fund mobile network extension are prevented by State aid regulations.

- 10.15 Opportunities for local gap funding of mobile network extension are frustrated by State aid regulations. Mobile technologies are licensed and regulated in a different way from physical infrastructure; and are not eligible for State aid in even the limited ways allowed for fibre set out in EU broadband guidelines⁹¹ as governed by the Treaty on the Functioning of the European Union (TFEU)⁹². Therefore, 4G is not deemed to be an NGA technology so BDUK money can't be used to intervene directly in this market. Moreover, the UK Government is reluctant to notify any further State aid schemes to the European Commission before Brexit- which means that any intervention must fall within the terms of the 'block exemption' for broadband infrastructure in Article 56 of the Treaty.⁹³

Signal repeater investment

⁹¹ Official Journal of the European Union (2013). EU Guidelines for the application of State aid rules in relation to the rapid deployment of broadband networks. European Commission, Brussels. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2013:025:0001:0026:EN:PDF>

⁹² European Commission (2009). Treaty provisions on State aid. http://ec.europa.eu/competition/state_aid/legislation/compilation/a_01_03_11_en.pdf

⁹³ Extract from Article 56 of the Treaty regarding funding limits and state aid - *Investment aid for local infrastructures: up to €10m or the total costs exceeding €20m for the same infrastructure to cover investment costs in tangible and intangible assets. The aid amount cannot exceed the difference between the eligible costs and the operating profit of the investment. It does not apply to infrastructure covered by other sections of the Regulation, except Regional Aid.* So it could not be used for a broadband project for example. The infrastructure should be made openly available to users with a market price charged.

- 10.16 Mobile/Wi-Fi network signal repeaters is a low-cost way of addressing some network gaps. Use of signal repeaters would allow households and businesses to extend mobile coverage using consumer equipment that would relay stronger signals to areas of poor coverage.
- 10.17 Use of signal repeaters is subject to regulation. Ofcom has recently completed a consultation on revising the regulations around mobile phone signal boosters, and mobile repeaters, as a way to boost mobile coverage in rural areas. The outcome is that Ofcom has decided to allow repeaters for domestic indoor use only - so a household can install a dish or aerial linked to a box that will extend GSM or Wi-Fi coverage in their home, but not outside of the home. This decision does not include offices or other commercial premises nor is it permitted to apply the exemption for equipment used to relay signals between premises, which still needs to be licensed under the WT Act 2003.

5G – the Government’s strategy

- 10.18 Next Generation Mobile Technologies: A 5G Strategy for the UK (March 17) published by DCMS and HM Treasury⁹⁴ sets out the Government’s ambitions regarding 5G:
- accelerating the deployment of 5G networks;
 - maximising the productivity and efficiency benefits to the UK from 5G; and
 - creating new opportunities for UK businesses at home and abroad, and encouraging inward investment

Applications/ benefits of 5G

- 10.19 The Government’s 5G strategy makes it clear that *5G is not yet fully developed, with definitive standards only due to be agreed in 2019 and incremental deployment expected over the following decade. Unlike the generations of mobile networks that have preceded it, 5G is not just an extension of existing technologies but a “system of systems” that will bring flexibility to mobile, fixed and broadcast networks and support ever larger data requirements (p6).*

5G - potential applications and use cases

- Whilst it is impossible to predict exactly where 5G will make the biggest impact, sectors across the whole of the economy are expected to make use of new 5G technologies and applications.
- There is widespread agreement that these could include transport and logistics; financial services; health and social care; retail; digital creativity and information services; and production, manufacturing and robotics.
- 5G could also enhance everyday consumer experiences - for example, as a result of seamless connectivity and advances in Artificial Intelligence and both virtual and augmented reality applications.
- Within each sector, we expect to see a number of different ‘use cases’ emerge as well as applications and services that will sit alongside them.
- So, for example, the lower latency (i.e. quicker reaction times) expected to be a feature of 5G networks could make it possible to support the large-scale use of driverless vehicles for the first time. Even within one specific use case - such as a journey from A to B in a driverless car - there are many potential sub-use cases: vehicle to vehicle connections; connections between vehicles and street infrastructure for traffic management; and high-speed connectivity to support in-car information and entertainment systems, to name just a few

Other possible use cases of 5G are many and varied. They could include:

⁹⁴ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/597421/07.03.17_5G_strategy_-_for_publication.pdf

- industrial predictive maintenance: helping to reduce running costs by warning about imminent equipment malfunctions;
- retail logistics: fleets of connected/driverless lorries and vans transporting goods across the UK;
- smart cities: improving quality of life in urban environments through applications like traffic management, streetlight control, waste management, and smart grids;
- agri-tech: increasingly precise and efficient farming to help meet the challenges of a successful agricultural sector; and
- augmented or virtual reality: offering new 'ultra-realistic' applications in gaming or giving sports fans the opportunity to 'play' alongside their favourite athletes.

5G could also support significant efficiencies in public service delivery. For example, 5G applications in the health sector, such as wearable sensors, could help to monitor people

P6/7 - https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/597421/07.03.17_5G_strategy_-_for_publication.pdf

Factors that may constrain/slow investment in, and rollout of 5G across the UK

10.20 When 5G technology and protocols are finalized, three sets of factors may yet slow/hinder its rollout:

- Access to sufficient spectrum
- Commercial business case issues
- Planning hurdles
- Limited fibre backhaul for the large number of masts/dishes needed to support 5G

Access to sufficient spectrum

10.21 Ofcom's auction of the 2.3Ghz and 3.4Ghz spectrum earmarked for 5G has already been delayed by MNOs, concerned about the potential costs and risks of regulation⁹⁵.

The commercial case for large scale investment in 5G rollout is not there yet and faces a number of issues

- 10.22 MNOs are pre-occupied with the costs and risks involved in establishing a 5G service, including: allocation and cost of spectrum; the requirement for full-fibre backhaul networks, required to operate the higher speeds of 5G compares with previous generations of mobile technology, some of which are still operating on copper connections; the increased costs of investment in other infrastructure - masts and electronics – to even match those levels of coverage currently available on 2G, 3G and 4G networks, let alone extend coverage to existing mobile 'not spots'; the potential period over which this investment may be recovered
- 10.23 This increases the risk that commercial operators will be unwilling to consider further investment in current mobile networks unless forced to by regulation
- 10.24 Evidence from a previous Government scheme that managed to extend mobile coverage to only a few thousand premises across the UK despite the investment of hundreds of millions of pounds of public subsidy on terms specified by infrastructure providers and MNOs, makes it extremely difficult to predict

⁹⁵ The Register: Ofcom Head Sharon White slams 5G hold-up in spectrum auction, 2 October 2017. https://www.theregister.co.uk/2017/10/02/ofcom_head_sharon_white_slams_5g_holdup_to_spectrum/

whether any combination of tougher licensing conditions on the operators and public investment in infrastructure can address the widespread concerns about poor mobile coverage in the GESP area

Planning hurdles and 4/5G

- 10.25 The Government has already introduced planning reforms in England which include a significant relaxation of restrictions on the siting and installation of small cells that will support both 4G and future 5G rollout. In particular, it has:
- legislated for additional permitted development rights for taller mobile masts;
 - removed the threshold for placing small cell antenna on commercial buildings and structures to support mobile rollout. This means MNOs can deliver a greater number of small cells to handle greater mobile capacity on their networks for 4G and, subject to how it will operate, 5G;
 - brought into effect new building regulations which require all new buildings and existing buildings undergoing major renovations to have infrastructure capable of delivering superfast broadband greater than 30Mbps.
- 10.26 However, given the sheer scale of infrastructure envisaged within 5G networks, there may still be a case for going further. Government intends to set out whether further changes are needed to the planning and regulatory system to meet the unique challenges of 5G infrastructure deployment and to review the position on a regular basis, using evidence from the implementation of the 5G testbeds and trials programme

Limited fibre backhaul for the large number of masts/dishes needed to support 5G

- 10.27 The high data rates of 5G means it will need many more masts/dishes, served by much higher capacity backhaul – fibre backhaul. The Government’s focus on promoting investment in local full fibre networks will, if successful, help address this.
- 10.28 The issue is likely to be most acute in country towns/ villages and rural areas given the higher relative costs and lower returns of investment in fibre networks rural areas. There is a risk that more rural parts of the UK, with lower population densities and larger distances to cover than urban centres, may get no commercial investment in 5G at all without some form of intervention that prompts MNOs to place a higher priority on those settlements and geographies. That may heighten digital exclusion in the future, as commercial and Government mobile services are increasingly developed to deliver a 5G experience.

Implications of, and issues for 5G in GESP

- 10.29 These issues may well be overcome nationally and if so, can be overcome in GESP, such that GESP could be in a position to optimize the significant benefits of 5G, and moreover, take a lead role in promoting/supporting and enabling ‘early’ 5G rollout

Benefits

- 10.30 Achieving early deployment of 5G across GESP, will be highly beneficial to both urban and rural areas, in terms of:
- Replacing 4G mobile phone services, providing much higher bandwidth and performance regarding the way we currently use 4G
 - But, providing the opportunity for much wider applications, examples of which are set out in the above ‘use case’ inset.
- 10.31 There is no question that achieving deployment of 5G in GESP, as soon as is feasible, is a priority.

Issues

10.32 The question is when will deployment of 5G across GESP be feasible

- 5G is still a test-bed concept – technologies and protocols are still under development – Government notes that deployment in the UK is likely to occur in the 2020s
- 5G, in whatever form it is eventually delivered will require substantial fibre-based back haul. It therefore depends on a successful local full fibre programme
- Deployment of 5G in rural GESP will be at an additional disadvantage in that the amount of fibre in market towns and rural areas is limited. Moreover, planning constraints may increase the difficulty and cost of finding sites for the increased density of ‘small cell’ transmitters needed to support the deployment of 5G.

What can GESP do to facilitate deployment of 5G

10.33 We see at two stage 5G strategy for GESP

- Taking an active flagship role in helping develop 5G technology and its applications
- Paving the way for 5G rollout, by making GESP more investment ready for 5G

Taking an active flagship role in helping develop 5G technology and its applications

- Government and intermediary agencies have issued a number of competitive funding rounds focussed on pilot programmes. GESP as far as we are aware has not bid into any of these as yet. It should seek to do so in the next available funding rounds.
- Examples of the types of pilot/demonstrator studies that GESP could seek to pursue include:
 - = 5G and smart settlements – focussing on development proposals which arise through the GESP
 - = 5G and one or several industry-sector applications
 - = 5G and precision agriculture

Taking an active flagship role in helping develop 5G technology and its applications

- Planning - GESP needs to address potential planning hurdles to masts/dish sites - Planning regulations are a key factor influencing a network infrastructure provider's ability to expand its network, as they govern where sites can be built and the physical appearance of the equipment that can be installed on such sites. The deployment of 5G will require a significant increase in the number of small radio cells - likely to be located on street furniture, the sides of buildings etc. - in order to facilitate the requirements of 5G networks. Therefore, flexible and fit for purpose planning regulations will be required to support the deployment of 5G networks.
- Fibre backhaul – actively implement all feasible measures possible to support and enable large scale investment in local full fibre networks across GESP, including in the rural areas

Public Wireless Projects (Wi-Fi/WiMAX)

Defining what we mean by public Wi-Fi

10.34 Wi-Fi services/access, for the purposes of this study, are usefully divided into two types:

- Wi-Fi available in your house or office, via the wireless router in your bedroom or office. The backhaul for the Wi-Fi is the ‘fixed-line’ service to your router. We might term this ‘private Wi-Fi’, which is password protected and can be regarded as an extension of your fixed line service.

- Wi-Fi available in the public realm, in public buildings, in visitor destinations. Although these services will require a fixed line back haul, they are conceptually different from home or office Wi-Fi, in that they are intended for public (mobile) use

10.35 Wi-Fi targets in strategies tend to focus on the latter rather than the former

Wi-Fi targets

- 10.36 Some strategies also seek to promote Wi-Fi targets in addition to mobile targets, most commonly in relation to availability of free or charged for Wi-Fi services in certain parts of the public realm, in public buildings and in some cases in visitor establishments such as cafes etc. Targets are set in terms of availability, cost and speed.
- 10.37 Alternatively, Wi-Fi availability is not set as an overall target but instead is treated on a project by project basis.

Issues/difficulties with public Wi-Fi projects

10.38 Many Wi-Fi projects however run into difficulty in a number of areas:

- Determining rights to access to public assets – e.g., lighting poles, street furniture, and public buildings – on which to mount transmitters and repeaters. Some ‘public’ assets are actually owned and maintained by third parties, and this can increase costs, complexity and contractual conflicts over their use for this purpose.
- Growing competition between mobile services and Wi-Fi services. Wi-Fi tends to be free or much lower cost per unit than mobile services and of recent a growing plethora of apps enable voice and video calls to be made over Wi-Fi, thus increasing direct competition with the mobile market.
- This competition between commercial mobile and public Wi-Fi services extends to access rights to locate transmitters and repeaters on public buildings – where mobile network operators may be willing to pay a premium for exclusivity
- Increasing competition with mobile operators increases State aid/competition issues regarding Wi-Fi projects

10.39 This suggests the need for carefully focussed/ targeted public Wi-Fi/WiMax projects

Conclusions/ recommendations - Wireless (Wi-Fi/WiMax)

- 10.40 We recommend that there are three key potential roles for public realm/public building Wi-Fi/WiMax projects
- Free Wi-Fi in public buildings and public realm
 - Exploring how to use public Wi-Fi projects to address/ compensate for gaps in 4G coverage
 - Exploring how to integrate Wi-Fi/WiMax technologies with 5G

11. Rural connectivity issues

11.1 This section explores the issues faced by GE's rural areas

Summary – GESP digital connectivity strategy – rural theme

- Rural connectivity issues include: remaining super-fast (NGA gaps), uncertainty over the effectiveness and timing of rollout out of a national 10 Mbps Universal Service Obligation for broadband, significant gaps in mobile coverage (4G) lack of clarity over what form 5G will take and need for substantial fibre backhaul
- This would suggest that the main policy priority for GE's rural areas is to explore measures that will ensure wide deployment of local fibre networks. This will provide the necessary backhaul for 5G, it will help address any remaining superfast gaps...and...it will help ensure that rural areas are not left out as the urban areas pursue local full fibre network deployment.
- Major investment required – which by the usual rules will not be deemed 'cost effective'. The 'traditional business models' of the incumbents (and even of the newly emerging altnets) which are urban focussed, are unlikely to work – investing in deep fibre in rural areas will be deemed not cost effective. This suggests that the market's traditional (and new) approaches, even with substantial Government gap funding, are unlikely to work fully or at all; this suggests that alternative, more radical, business models need to be considered. This is only likely to happen if the local authorities and local communities take pro-active action to do this.

Conclusions

- From this we conclude that there is a case for a rural theme in the GE digital connectivity strategy, either as stand-alone or as a continuation of urban themes in the strategy - no matter how much funding might be available from central government and/or the incumbents and altnets for investment in local fibre networks in rural areas, it is very likely to fall short of the total required. Without 'more radical initiatives at the local level', a similar pattern to previous rural deployments seems likely, namely patch-work, uneven and delayed deployments with a proportion being left out.
- Time for more radical models - for these reasons and given that Government for the first time is suggesting that local authorities and local communities play a much more prominent, if not lead role, in initiating and funding local fibre deployments, we see the time being right to explore new, alternative local fibre funding, ownership and operational models, perhaps replicating earlier successful projects such as Cybermoor/B4RN or at least drawing in these.
- Certain project themes being promoted by DCMS's current Local Full Fibre Programme competition would seem to be particularly pertinent. For example, the GE digital connectivity strategy could promote a public-private-community based **fibre investment, build and manage** vehicle, that leverages existing public- sector connectivity spend, any publicly owned networks, LFFN grant and institutional investment funding, enabled by the National Infrastructure Commission's fund managers (e.g. Amber)
- There would be trade-offs for such a project – funding new dig in rural areas, with the consequent higher unit costs, would mean there is less funding available for urban areas, but an urban-rural model will enable cross subsidy to be explored.
- The options are complex and need to be considered by stakeholders; a project team will need to be assembled (comprising local authority officers, other stakeholder organisations and with specialist consultancy support), a business model and options appraisal will need to be prepared/undertaken, as part of the LFFN bidding process. The amount of work involved for just the urban element is substantial; including the rural element will increase the level of preparatory work required significantly. The time required to prepare a business case and options appraisal, including time for consultation and discussion is in our view at least 3 months

Rural connectivity issues

11.2 Rural issues, as noted in the earlier chapters that map current connectivity and gaps are:

- Remaining super-fast (NGA gaps), of which most but not all are proposed to be addressed by, or are capable of being addressed by CDC's remaining programmes
- Uncertainty over the effectiveness and timing of rollout out of a national 10 Mbps Universal Service Obligation for broadband
- Significant gaps in mobile coverage (4G) which can only be effectively measured and also which can only be effectively addressed at the national level between DCMS and Ofcom – 4G gaps adversely affect rural households, rural business premises, farms and farming activities – and whole new settlements
- And although 5G is still only at test bed stage, there is certainty that whatever form it takes, it will require substantial backhaul, which can only really be effectively provided by local fibre networks in rural areas

Implications

- 11.3 This would suggest that the main policy priority for GE's rural areas is to explore measures that will ensure wide deployment of local fibre networks. This will provide the necessary backhaul for 5G, it will help address any remaining superfast gaps...and...it will help ensure that rural areas are not left out as the urban areas pursue local full fibre network deployment.

Major investment required – which by the usual rules will not be deemed 'cost effective

- 11.4 Although details of existing fibre networks are confidential and therefore are not publicly available and cannot be mapped cost effectively, we can be reasonably certain that even BT has limited fibre network in rural areas. Hence the scale of network build required will be proportionally large. In addition, rural fibre deployments will suffer from similar issues to earlier broadband deployments, namely long distances (and hence high dig costs) to small and dispersed communities, resulting in very high cost per user.
- 11.5 The 'traditional business models', of the incumbents (and even of the newly emerging altnets) which are urban focussed, are unlikely to work – investing in deep fibre in rural areas will be deemed not cost effective.
- 11.6 This suggests that the market's traditional (and new) approaches, even with substantial Government gap funding, are unlikely to work fully or at all; this suggests that alternative, more radical, business models need to be considered. This is only likely to happen if the local authorities and local communities take pro-active action to do this.
- 11.7 This suggests that there is a case for a rural theme in the GE digital connectivity strategy, either as stand-alone or as a continuation of urban themes in the strategy.

We suggest that the GE digital connectivity strategy includes a rural theme, either stand-alone or as part of GE wide themes.

- 11.8 We would suggest that no matter how much funding might be available from central government and/or the incumbents and altnets for investment in local fibre networks in rural areas, that it will fall short of the total required. Without 'more radical initiatives at the local level', a similar pattern to previous rural deployments seems likely, namely patch-work, uneven and delayed deployments with a proportion being left out.
- 11.9 For these reasons and given that Government for the first time is suggesting that local authorities and local communities play a much more prominent, if not lead role, in initiating and funding local fibre deployments, we see the time being right to explore new, alternative local fibre funding, ownership and operational models, perhaps replicating earlier successful projects such as Cybermoor/B4RN (see below), or at least drawing in these.

- 11.10 Certain project themes being promoted by DCMS's current Local Full Fibre Programme competition would seem to be particularly pertinent. For example, the GE digital connectivity strategy could promote a public-private-community based fibre investment, build and manage vehicle, that leverages existing public- sector connectivity spend, any publicly own networks, LFFN grant and institutional investment funding, enabled by the National Infrastructure Commission's fund managers (e.g. Amber)
- 11.11 There would be trade-offs for such a project – funding new dig in rural areas, with the consequent higher unit costs, would mean there is less funding available for urban areas, but an urban-rural model will enable cross subsidy to be explored.
- 11.12 The options are complex and need to be considered by stakeholders; a project team will need to be assembled (comprising local authority officers, other stakeholder organisations and with specialist consultancy support), a business model and options appraisal will need to be prepared/undertaken, as part of the LFFN bidding process. The amount of work involved for just the urban element is substantial; including the rural element will increase the level of preparatory work required significantly. The time required to prepare a business case and options appraisal, including time for consultation and discussion is in our view at least 3 months.

Examples of successful local rural initiatives to draw on

- 11.13 There are a number of interesting rural community broadband projects elsewhere to consider replicating, or at least drawing form, in GE.
- 11.14 Two such examples are CyberMoor and B4RN
- Cybermoor – Daniel Heiry who set up and led this project, is a member of the Adroit Broadband Consortium. He is also a member of the Community Broadband Network, which regularly works with Adroit and vice versa. Daniel is not a member of our current team for this study but has kindly provided access to a detailed 'write up' of Cybmoor which we provide extracts from below, as an example of one such project.
 - B4RN – this project has just been reviewed in depth by Point Topic and we provide extracts from that review below
- 11.15 Further details are provided in the Appendices.

12. Conclusions: consumer broadband availability gaps in GE

Provision of digital connectivity services against targets in GE – and the key gaps that require policy intervention

- 12.1 The GESP digital connectivity strategy needs to understand the extent and location of current gaps in availability of digital connectivity services – fixed (to households and businesses) but also mobile (4G) – measured against targets.

Availability against current NGA fixed line and 4G mobile targets

- Fixed-line NGA – there is incomplete coverage of Next Generation Access (NGA) - hybrid fibre and copper networks (utilising fibre to the cabinet technology), offering ‘superfast’ connections such as BT Infinity and Virgin Media. Parts of the city of Exeter, its suburbs, large parts of rural towns and wider rural areas do not have NGA access; and some premises within those areas with NGA do not have ‘superfast’ speeds, because of the distance from the nearest fibre-enabled cabinet.
- Outdoor 4G mobile coverage is incomplete, and indoor coverage levels, though known to be lower, are unknown. In addition, some areas are served by only one mobile network operator (MNO), which means that effective coverage for individual consumers is much worse than suggested by figures published by Ofcom which simply assume that if one MNO covers an area then it is covered.

Availability against future gigabit fixed line and 5G targets

- Other than dedicated lease line services, there is currently only limited availability of ultrafast consumer broadband services to SMEs or households in the GESP area
 - = New developments – such as Cranbrook – have partial fibre-to-the-premises (FTTP) coverage, but limited competition between ISPs limits the range of ‘over the top’ (paid content) services available.
 - = G-fast has not been rolled out to date in the area
- 5G is still only at concept stage and moreover, will be dependent on extensive local fibre access network investment to provide the backhaul.

Headline points from Point Topic’s broadband service availability analysis across Exeter/Devon local authorities

Household connectivity

Number and distribution of households by availability of download speed by speed band

- 11% of households are in areas offering download speeds of less than 10 Mbps
- 14% are in areas offering between 10-30 Mbps
- 57% are in areas offering 30-100 Mbps
- 18% are in areas offering more than 100Mbps

Business connectivity

Number and distribution of businesses by availability of download speed by speed band

- 11% of business premises are in areas offering download speeds of less than 10 Mbps
- 23% are on areas offering between 10-30 Mbps

- 58% are in areas offering 30-100 Mbps

Analysis of business connectivity by type of businesses premises⁹⁶

- 38% of factory business premises are in areas offering less than 30 Mbps download speed
- 35% of warehouse business premises are in areas offering less than 30 Mbps download speed
- 34% of office business premises are in areas offering less than 30 Mbps download speed
- 30% of retail business premises are in areas offering less than 30 Mbps download speed

Focus on sub-10 Mbps download speed

Sub-10 Mbps household connectivity

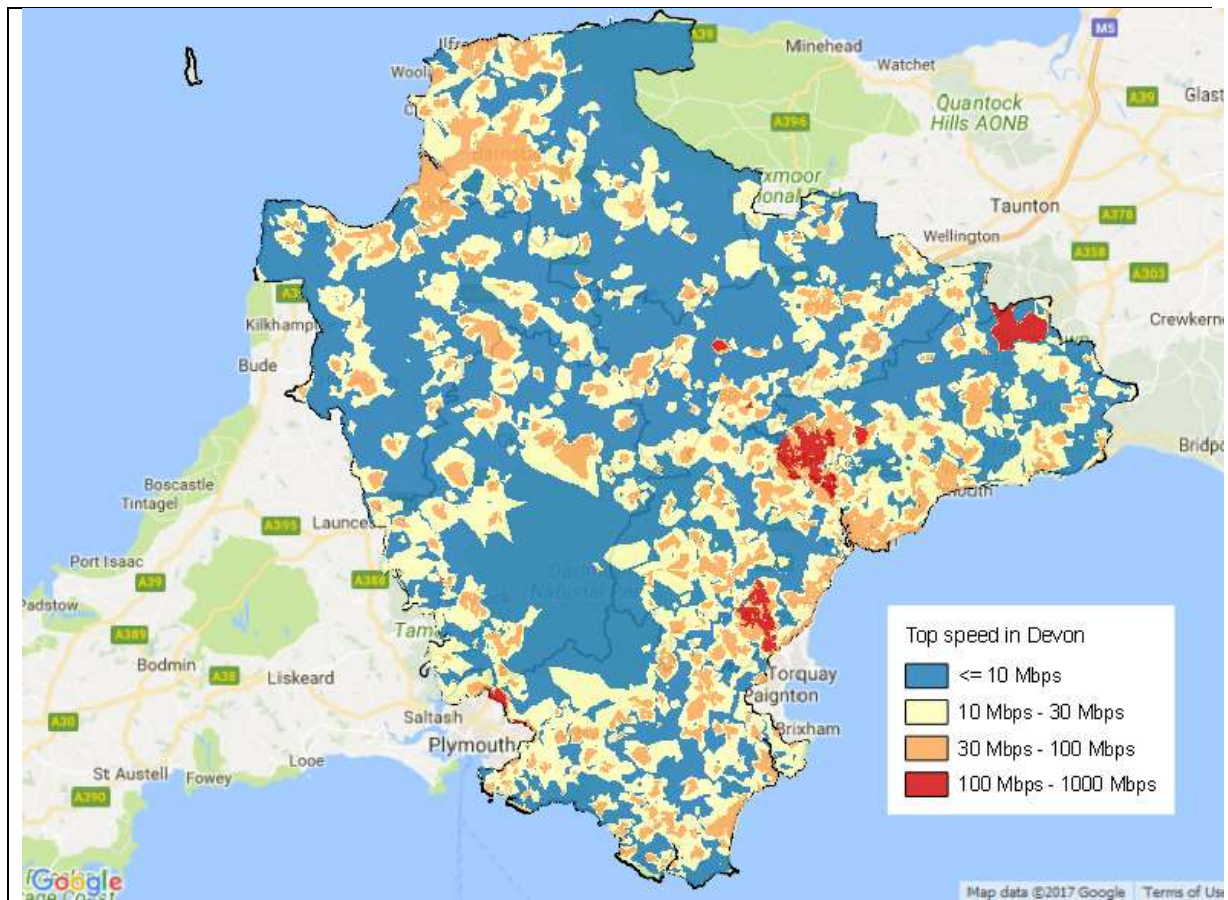
- An average of 11.4% of households are in areas offering download speeds of less than 10 Mbps across the 4 authorities
- 4.2% of total households are in areas offering less than 5 Mbps, and
- 1.8% are in areas offering less than 3 Mbps

Sub-10 Mbps business connectivity

- an average of 10.7% of business premises are in areas offering download speeds of less than 10 Mbps across the 8 authorities
- 3.8% are in areas offering less than 5 Mbps, and
- 1.5% are in areas offering less than 3 Mbps

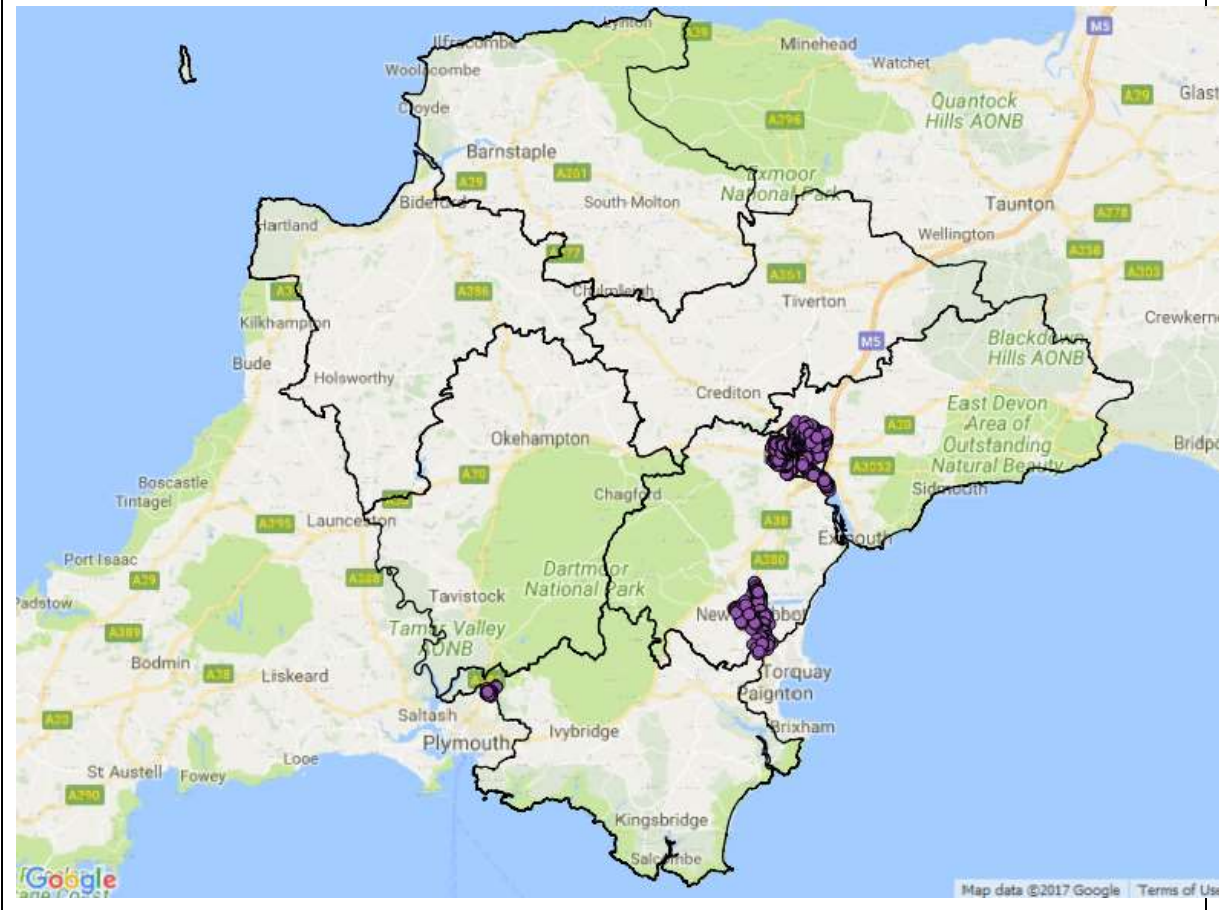
Top speed heat map – all services – Point Topic

⁹⁶ The Adroit-Point Topic coverage modelling also allows us to examine coverage by broad type of business premises based on classifications in the Valuation Office Agency data sets



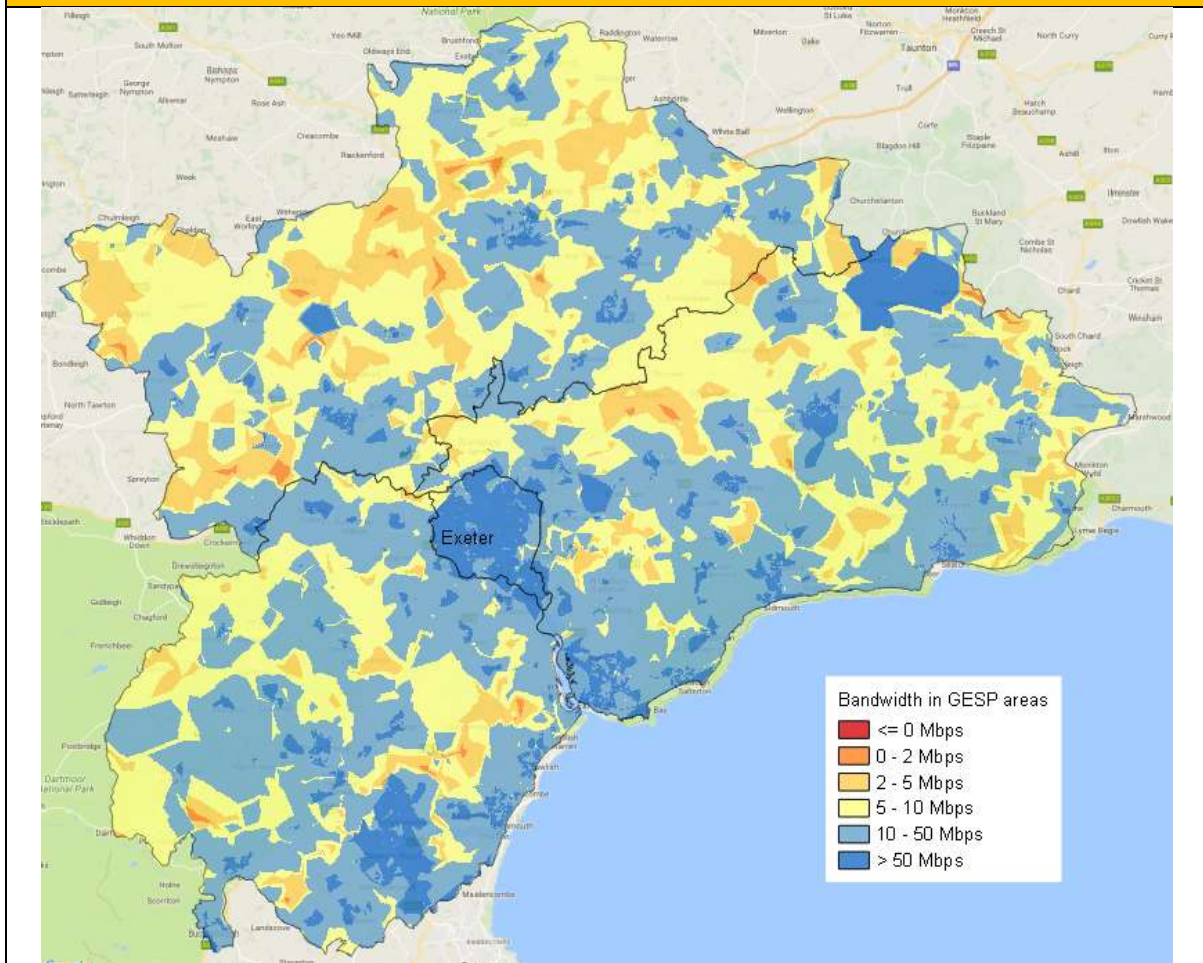
- Virgin's commercial offer covers 11% (3,283) post codes in Devon, with concentrations in Exeter and Newton Abbot (see map below).

Virgin Coverage (Point Topic)



- Analysis of sub-10 Mbps download speed service availability

Sub 10 Mbps download speed analysis – Point Topic



Forecast commercial deployment [without this strategy]**USO**

- Legislation for a national 10 Mbps USO was included in the Digital Economy Bill, passed in April 2017. BT has expressed its 'willingness' to extend 10Mbps coverage to 99% of premises by 2020. However, there is no firm deadline for its implementation.⁹⁷ The results of a DCMS consultation⁹⁸ on design of the USO are not yet known. However, it is currently the responsibility of BT, not local authorities, to deliver this, therefore unlikely to be funded

Superfast (NGA)

- Phase 1 of Connecting Devon & Somerset (CDS) met its original target of 90% of premises within the initial Open Market Review (OMR) passed with NGA services of 24Mbps, almost exclusively in the form of fibre-to-the-cabinet (FTTC). However, the number of residential premises increased over the period of delivery with many of them not being served by superfast connections, leaving final coverage below 90%.
- Contracts for Phase 2 of CDS were won by Airband, which provides a fixed wireless service to 12,000 premises in western Devon, and Gigaclear, which is contracted to deploy fibre-to-the-premise (FTTP) to 40,000 premises by the end of 2019. This will bring broadband services with average download speeds of 30Mbps to over 95% of premises in Devon and Somerset.

Ultrafast

- BT has responded to competition with limited commercial deployments of FTTP, including in the city of Exeter. In the new town of Cranbrook, alternative network provider IFNL, under the brand name 'See The Light', delivered FTTP coverage to the first phase of 1,120 premises (out of 8,000 planned dwellings.)
- We understand that Exeter City Council is in negotiation with another alt net to deploy full fibre networks. Details of ISPs that may be offering services, and domestic and business packages and pricing, are not available at time of writing.
- G-Fast – BT's deployment plans are shown in Point Topic's data sets. By 2025, it is anticipated that BT will have deployed G-Fast in 9.1% (2691) of Devon's post codes
- Virgin – Light Speed – Virgin proposing new network deployment but plans not confirmed for Devon

Mobile – 4/5G

- CDS is awaiting the outcome of discussions with Ofcom that will allow individual MNO coverage maps to be shared with itself and with local authorities, to derive a clearer idea of the gaps in both outdoor and indoor coverage. At the end of 2015, it was estimated that 7,000 premises across Devon and Somerset were unable to get mobile coverage indoors or outdoors. (This included all premises in Cranbrook.)

Conclusions drawn from the gap analysis

⁹⁷ 'Lords water down push for minimum broadband speed,' Financial Times, 26 April 2017.

<https://www.ft.com/content/23618b9e-2903-11e7-bc4b-5528796fe35c> (accessed 17 November 2017)

⁹⁸ Department for Digital, Media, Culture & Sport (2017). Broadband Universal Service Obligation: consultation on design. (closed 9 October 2017) <https://www.gov.uk/government/consultations/broadband-universal-service-obligation-consultation-on-design>

12.2 The gap analysis suggests that, even allowing for future ‘market’ investment in new infrastructure and services, that gaps at all target levels are likely to remain. This provides the rationale and justification for the GE Digital Connectivity Strategy to focus on the following issues:

- Finishing the superfast job, i.e. ensuring 100% accessibility to >30Mbps broadband
- Kick starting ultra-fast (full fibre)
- Exploring what can be done to address current 4G gaps
- Preparing the way for 5G

Finishing the super-fast job

12.3 Phase 2 of CDS is on target to achieve its target of 95% of premises passed by services with average download speeds of 30Mbps by the end of 2019. This includes an element of re-investment in properties where the Phase 1 intervention resulted in lower speeds.

12.4 There may be an opportunity – using gainshare⁹⁹ accruing from increased levels of take up in areas benefitting from the national Broadband scheme, for example – for further procurements on the basis of an Open Market Review, on the lines developed by CDS, to intervene further in prioritising those who are totally digitally excluded.

12.5 There is also an option to look at ways to extend 4G coverage – although this may raise challenges in State aid, procurement and planning.

Kick-starting ultra-fast (full-fibre)

12.6 Plans for commercial development of new FTTP by ‘altnets’ are unlikely to extend to rural towns and deep rural area, but they may spur Openreach into accelerating its own commercial investment in areas that are currently unable to access NGA services, whether on the basis of NGA, G. Fast or full fibre.

12.7 The priority for the GESP digital connectivity strategy will be to encourage and facilitate greater investment in local full fibre networks.

12.8 The GESP digital connectivity strategy will need to consider a cocktail of measures designed to get more fibre in the local access network

Full-fibre – two core themes

- Two core themes
 - = Making the GESP area more investment ready by telecoms infrastructure investors
 - = Assisting, facilitating and co-funding telecoms infrastructure investment

⁹⁹ Gainshare refers to grant clawback from BT in relation to the locally delivered (CDC) BDUK national gap funding programme, when take up rises above pre-agree clawback thresholds.

13. GE Digital Strategy

Centred around six themes

13.1 The proposed GE digital strategy focusses on six themes:

Making the area as investment-ready as possible	Supporting and driving investment in local full fibre networks
Theme 1 On-site – new settlements, brownfield developments (business and residential) and all other developments above a minimum threshold are encouraged/ required (by planning) to install fibre optic duct alongside other utilities/services, at the design and build stage¹⁰⁰. This will make it easier, reduce the costs and increase the likelihood of telecoms service providers installing network and offering services to occupiers once the scheme is complete. This will open up choice and stimulate competition	Theme 3 Demand-side – a voucher scheme, offering subsidy to customers (SMEs, households) to pay for extra-over connection costs. The LFFN programme proposes a giga-bit capable voucher scheme, ensuring that only network capable of supporting giga-bit connectivity (e.g. fibre) is funded
Theme 2 Public realm – administrative and regulatory costs, delays, difficulties, risks and uncertainties, regarding street works, highways and planning, are minimised/ removed to telecoms investors when digging duct, laying cable, sighting masts, dishes and antenna	Theme 4 Supply-side – new local authority/ community investment and business models, reflecting guidance in the LFFN programme – for example, leverage publicly owned network, sites and premises, coupled with current annual connectivity spend, to attract external investment in local full fibre network
Theme 5 Supportive/ cross-cutting actions – for example establishing one or more local Digital Exchanges; aligning strategically with other initiatives and developments so far as possible; formulating an effective digital skills strategy	Theme 6 Future technologies, future applications – such as exploring the role of and need for digital connectivity to support the functions of smart cities/ smart settlements, and how this applies to those developments being proposed by the GESP for GE; piloting and development of 5G technologies, paving the way for early adoption in GE and exploring the digital connectivity requirements of agriculture

¹⁰⁰ Installing duct alongside installation of other utilities is much lower cost than installing duct on its own, as the dig costs can be shared/apportioned

	and opportunities for GE to become earlier adopters
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Making the area as investment-ready as possible	
Theme 1	
<u>On-site</u> – new settlements, brownfield developments (business and residential) and all other developments above a minimum threshold are encouraged/ required (by planning) to install fibre optic duct alongside other utilities/services, at the design and build stage¹⁰¹. This will make it easier, reduce the costs and increase the likelihood of telecoms service providers installing network and offering services to occupiers once the scheme is complete. This will open up choice and stimulate competition	
1a dissemination	1a.1 Promote evidence that shows tenants/occupiers demand broadband-ready buildings
	1a.2 Prepare illustrative design and costing specs
1b encouragement	1b.1 Promoting building digital connectivity standards, accreditation and certificate – e.g. Wired Score
1c regulation	1c.1 Adopt appropriate digital connectivity policy in the GESP, local plans and supplementary documents Incorporate appropriate policy into the GESP and the local plans to ensure all relevant developments include appropriate provisions to ensure that current and future digital connectivity aspirations can be secured, wherever possible Section 20 identifies a series of challenges and opportunities pertaining to improving the connectivity of development sites, alongside an evaluation of the different planning policy interventions available to the GESP authorities at the GESP and at the local authority levels. Consider implementation of the suggested policy wording for the GESP identified in section 20. Further consider the range of options available for each local authority, in addition

¹⁰¹ Installing duct alongside installation of other utilities is much lower cost than installing duct on its own, as the dig costs can be shared/apportioned

Making the area as investment-ready as possible	
Theme 2	
<u>Public realm</u> – administrative and regulatory costs, delays, difficulties (street works, highways and planning) are minimised to telecoms investors when digging duct, laying cable, sighting masts, dishes and antenna	
2a. Off-site (public realm) works – ‘holes and poles’ (cabinets and masts)	2a.1 Reduce delays, make simpler and reduce arbitrary costs of highways/ street works – drawing on the BSG’s ¹⁰² recent report for TechUK that highlights the issues and recommends solutions ¹⁰³ . Consider including additional measures based on what other local authorities are doing – for example, relaxing parking restrictions on telecoms vans.
	2a.2 Ensure a proactive planning environment for infrastructure that requires planning permission, such as masts. As ‘permitted development’, cabinets and poles cannot benefit from this.
2b. Between sites – easements/way-leaves	2b.1 Help make it easier for the local telecoms industry and development industry to secure easements/ way leaves giving access across public and private land/sites in. Difficulty in securing rights of way can result in major delays and additional costs. One of the key ways of helping to address this is to promote a standardised way leave document template (such as that developed by the City of London) to the local telecoms and development industry ¹⁰⁴ .
2c. Financial contribution fund	2c.1 Consider the appropriateness of planning mechanisms to capture financial contributions on a local authority basis towards increasing the connectivity of and between areas. These options primarily concern the Community Infrastructure Levy or Section 106 Agreements.

¹⁰² Broadband Stakeholder Group

¹⁰³ Report available to TechUK members – contact TechUK for further details

¹⁰⁴ Contact City of London Authority’s digital connectivity policy team for further details

Supporting and driving investment in local full fibre networks	
Theme 3	
<u>Demand-side</u> – a voucher scheme, offering subsidy to customers (SMEs, households) to pay for extra-over connection costs. The LFFN programme proposes a giga-bit capable voucher scheme, ensuring that only network capable of supporting giga-bit connectivity (e.g. fibre) is funded	
3a. Voucher scheme	3a.1 Submit a GESP-wide bid to the Government’s new ultra-fast ‘gigabit-capable’ voucher scheme. This was launched in late summer 2017 as part of the Local Full Fibre Networks (LFFN) Programme and requires local authorities to competitively bid for funding. We understand that DCMS may favour multi-local authority bids. The next bidding round is proposed for the Spring

Supporting and driving investment in local full fibre networks	
Theme 4	
<u>Supply-side</u> – new local authority/ community investment and business models, reflecting guidance in the LFFN programme – for example, leverage publicly owned network, sites and premises, coupled with current annual connectivity spend, to attract external investment in local full fibre network	
4a. Leverage PSN and public-sector telecoms assets	4a.1 Aggregate PSN contracts in order to offer to the telecoms market a large-scale contract with guaranteed revenue streams through an appropriate procurement process. The tender response evaluation criteria should include a mix of PSN value for money coupled with commitment to invest in off-foot print network
	4a.2 Make public assets available for telecoms suppliers to use, through appropriate procurement/partnership routes. Assets include publicly owned duct, dark and lit fibre; public land and buildings as locations/sites for poles, masters, dishes and antenna.
	4a.3 Explore new innovative public/ private/ community funding, ownership and operation delivery vehicles as indicted in the LFFN bidding guidance, that combine 4a.1 and 4a.2
4b. Small bottom-up initiatives	4b.1 Work with 'excluded' local communities to explore DIY options. One approach of the 'do-it-yourself' model is the Swedish approach where the municipality funds fibre rollout along the principal highways and residents/businesses/farms either side dig their own ducts and lay their own fibre, acting collectively, and using farm trenching tools etc.
4c. A rural wide initiative	4c.1 Explore rural-wide innovative public/ private/ community funding, ownership and operational delivery vehicles, drawing on examples from elsewhere such as Cybermoor/B4RN and/or formulating a bespoke GE model, drawing on the suggestions provided by the LFFN bidding guidance

Supporting and driving investment in local full fibre networks	
Theme 5	
Supporting, cross-cutting actions	
5a. Local digital exchange initiative	5a.1 Seek to establish a local digital exchange ('DX') in association with a digital technology cluster and/or a digital skills provider, such as the university/a college. The Brighton Digital Exchange (http://bdx.coop) offers an example of how this can be done using de minimis funding. A DX would attract diverse network and service providers, create an interconnection facility, provide the basis for establishing a local data centre facility, and provide space for digital businesses; co-located with the data centre and enabling hands-on working with servers, enabling digital SMEs to benefit from a wider spectrum of the value chain in online services and applications
5b. Digital skills strategy	5b.1 Identify partners/ stakeholders with an interest in digital skills and hold a workshop to explore the need/opportunity, scope and approach towards formulating, funding and implementing an effective digital skills strategy. Align this so far as possible with emerging work at a LEP level, linked to national pilots with DCMS and industry. The HotSW LEP Digital Skills Partnership is expecting to shortly undertake a mapping and gapping exercise of digital skills needs in businesses and training provision available.

Supporting and driving investment in local full fibre networks	
Theme 6	
Future technologies, future applications	
6a. Formulate forward looking digital policy objectives for proposed new developments	6a.1 Digital strategy for new developments proposed by GESP – in this study we have modelled the bandwidth/ digital infrastructure required to support smart city applications for an indicative new settlement. We have also prepared high level cost estimates of building new fibre networks to provide the backhaul and to provide full local access fibre networks across each settlement. This will provide a foundation for future GE digital connectivity strategy policy to ensure appropriate digital infrastructure is included at the planning and design stages of all proposed new developments
6b. Undertake pilots in emerging new connectivity technologies/ applications	6b.1 Piloting and demonstrating 5G – Govt expects 5G to start to be commercially rolled out early next decade. The immediate opportunity for GE therefore is to take part in finalising the development of 5G as a viable commercial technology, through undertaking one or more funded pilot/test bed programmes
	4b.2 The digital farm – in this study we have reviewed, in outline, the opportunities and issues associated with providing digital connectivity, not just to farms, but across all fields to enable cost-effective precision farming. Technology issues remain, and we recommend that GE takes part in future pilot/ test bed studies on GE farms. This will raise awareness of the opportunities amongst GE farming communities and enable GE to be an early adopter, as and when the technology issues are resolved
6c. Establish a futures technology watch	6c.1 Establish a digital connectivity technology futures/ foresight watch function within the strategy team in order to identify emerging new technologies and applications that the local authorities can feasibly bid for funding for and take part in pilots/ demonstrators

14. GEDA Theme 1 (investment readiness) on-site measures

Issues

- 14.1 A lot of new buildings and development sites are not 'fibre-ready'. They do not have fibre ducting across the site and fibre risers in multi-level buildings built in at design stage, alongside the other utilities and services.
- 14.2 This means that any digital connectivity service provider wishing to offer fibre-based services to occupiers faces considerable additional installation cost, delay and disruption.
- 14.3 Ensuring buildings, particularly new build, and development sites in general have suitable duct/riser space designed-in and built-in during construction, rather than as an afterthought, removes unnecessary cost and delay barriers to the telecoms industry. Retrofit takes longer, involves digging up newly laid access roads, pathways and landscaping; retrofit is similarly problematic within buildings and may even be impossible in some situations.

How to address these

- 14.4 The ideal situation is to ensure that the architects and civil and (M&E) engineers include appropriate duct space/ risers and termination space, at the design stage, to the building and within the building, combined with the other utilities (electricity, gas, water, sewage) in an integrated utilities plan. And, although more difficult to achieve, there is a case for ensuring that existing buildings, when being refurbished/ redeveloped include duct and riser space etc., as far as is possible. The cost of inclusion at the design stage is far less than retrofit.
- 14.5 Both the landlord and occupier benefit.
- 14.6 Designing-in appropriate duct/riser/termination/interconnection space makes it far easier and less costly for suppliers to deploy fibre to and through the building; it also encourages/ enables more than one supplier to easily run services to the building and to inter-connect, thus providing choice and competition to occupiers; this helps attract occupiers and in tenanted buildings, this boosts demand from tenants which can only enhance rents and capital values.
- 14.7 Developers and landlords need to be encouraged to ensure their schemes are 'fibre-ready'. This can be done through a combination of awareness raising and where required, encouragement/ requirement through the land use planning system.

Actions to consider taking

- 14.8 The GE digital connectivity strategy should consider:
 - Establishing a developer forum/ working group – through which the issues, the relative costs and benefits can be discussed
 - Promote a building digital connectivity certification platform
 - Include appropriate policy in strategic and local plans, designed to raise awareness, encourage and where necessary, require new schemes above a certain size threshold to include appropriate telecoms infrastructure (e.g. open access fibre ducting) at design stage
- 14.9 In more detail:

Promote evidence that shows tenants/occupiers demand broadband-ready buildings

- The GE SME broadband survey undertaken as part of this research showed that fast broadband is important to a significant proportion of SMEs when looking for new or additional premises

- = **ACTION:** The SME survey results need to be packaged and disseminated to landlords and developers; the results also form part of the evidence base needed to justify including requirements for the provision of broadband infrastructure duct and trunking in new build in planning policy.

Prepare illustrative design and costing specs

- Developers/investors need to know what the additional costs of delivering a broadband-ready new build/ retrofit are, showing in particular the most cost-effective solutions and that inclusion in the design stage for new builds, is far cheaper than retrospective retrofit
- A number of illustrative schemes could be specified and costed, and the results packaged up and disseminated to developers and investors

- = **ACTION:** Commission consultants to prepare illustrative costings

Promoting building digital connectivity standards, accreditation and certificate – e.g. Wired Score

- Wired Score, originally formed in New York, now operating also in Greater London (initially funded by the GLA) and other regional cities, provide a detailed broadband building connectivity specification against which landlords can have their buildings accredited.
- Wired score initially provided a new-build accreditation but are in the process of providing a retrofit accreditation in the UK – copies of the UK new build specification and of the US retrofit accreditation are available on request (the UK retrofit version is still under production)
- We suggest that GE considers promoting a building broadband/connectivity accreditation scheme across the area. It is probably easier and more feasible to promote an established scheme than create a new one. The only established scheme, at this point, in the UK, is the wired score scheme. The more local authorities that adopt and promote the scheme, the more universally recognised and hence effective it will become.

- = **ACTION:** The opportunity to, and value of, Wired Score accreditation needs to be promoted to landlords/ developers in GE. The first step is to set up a meeting with Wired Score and GE officials to work out the best way of doing this, respective roles, timetable and resource requirements. The Wired Score specification will also provide reference material to be cited in policy requiring inclusion of duct and trunking broadband provision in new builds

Adopt appropriate digital connectivity policy in the GESP, local plans and supplementary documents

- Incorporate appropriate policy into the GESP and the local plans to ensure all relevant developments include appropriate provisions to ensure that the aspirations of the digital connectivity strategy can be implemented and to provide flexibility for future technological advancements.
- At their time of adoption, planning policy interventions should reflect up-to-date Government and industry foci. The Government's current focus is on 'full fibre' and where reasonable, planning policy interventions should look to make provision for inclusion of ducts and risers, across qualifying sites and in-building (where multi-storey), including connection spaces. The design and specification of these need to meet the operational-technical needs of all (or the vast majority) of suppliers.
- The nature of digital connectivity technology and infrastructure will almost certainly change considerably over the lifetime of the GESP (to 2040). Therefore, planning policies should reflect

this, and at the time of consideration, should promote the Government's then current broadband policy. The underlying principles behind the plan will remain constant however; namely to ensure that necessary access/connection routes/spaces are designed in, along with the other utilities, at construction phase.

15. GEDA: Theme 2 (investment readiness) – public realm

Issues

15.1 Commonly cited ‘holes and poles’ issues that impede digital connectivity infrastructure deployment are:

- **Securing permission to dig up highways/footpaths/ other public realm in order to lay ducting** – lack of co-ordination between highways authorities, different processes, different charging regimes for licenses all serve to delay the process, make it more expensive and more uncertain. There is also a significant amount of inconvenience caused to local people and inefficiency with regards to other works to highways etc. that could be co-ordinated.
- **Securing legal rights of way¹⁰⁵ across land and into buildings for duct/ siting of poles/cabinets/masts/dishes** – lack of standardised fit-for-purpose way leave documentation; difficulty in identifying and contacting absentee landlords; delays and costs involved in agreeing way leaves – all these factors can significantly slow network build and add cost.
- **Securing planning permission for masts** – lack of standardisation in the process, lack of clarity in planning policy, failure to engage in the planning process and/or at the correct stage all add further delay and cost.
- **Facilitate access to street furniture, roofs/ walls of public buildings for masts/dishes** -one of the conclusions of a recent TechUK round table discussion on barriers to digital connectivity¹⁰⁶ was that local authorities should make it as easy as possible for suppliers to install masts, dishes, cabinets and other telecoms infrastructure equipment on/using public sector assets (land, roofs, sides of buildings, lamp posts, and other street furniture). This was thought to be particularly important to support the rollout of 5G infrastructure which may require siting of a relatively large number of small transmission/receiver devices
- **Cross subsidy of site backhaul connection costs** - Consider the appropriateness and mechanisms for securing a financial contribution from ‘large’ schemes towards connection from the site to one or more local PoPs (points of presence)

How to address these and Actions to consider taking

Reduce road dig license fees; co-ordinate and harmonise easier license application process; remove delays

- Reduce delays, make simpler and reduce arbitrary costs of highways/ street works – drawing on the BSG’s¹⁰⁷ recent report for TechUK that highlights the issues and recommends solutions¹⁰⁸. Consider including additional measures based on what other local authorities are doing – for example, relaxing parking restrictions on telecoms vans.

= **ACTION:** Analysys Mason’s recommendations should be implemented. This issue is best addressed at the GESP level.

Access street furniture and other public assets to sight masts, dishes, antenna.

¹⁰⁵ Via an easement/ way leave

¹⁰⁶ Conclusions are provided to TechUK members only. Adroit Economics is a member and has drawn on the conclusions for the purposes of this study. Readers are also encouraged to contact TechUK direct if they require further information

¹⁰⁷ Broadband Stakeholder Group

¹⁰⁸ Report available to TechUK members – contact TechUK for further details

- Ways in which public sector can facilitate/ make it easier for suppliers to access and use street furniture and other public-sector assets include: agreement at board/director level on the principles and terms via which suppliers can gain access; standardized terms/documentation; clear simple application process minimising delays; minimize license/ other costs to suppliers.

= **ACTION:** This issue can be tackled best at the GESP level, not least because suppliers need common standards/processes/ pricing across all of the GE area. The first step would be to host a round table workshop with suppliers.

Make planning process for masts etc. easier

- The counter-part to embedding broadband infrastructure requirements in planning policy to ensure appropriate infrastructure is included in new build, is to help streamline/make simpler/faster the process of suppliers securing planning permission for broadband infrastructure equipment. The Analysys Mason report for BSG (noted above) also includes recommendations on this.

= **ACTION:** Ensure a proactive planning environment for infrastructure that requires planning permission, such as masts, as 'permitted development', cabinets and poles cannot benefit from this. The first step would be to host a round table workshop with suppliers

Facilitate use of standardized way leave (City of London)

- The standardized way leave, developed by the City of London, is now being used by a significant number of suppliers, developers/landlords and some local authorities, particularly in London. The aim is to promote and support its use across the GE area, particularly with developers/landlords.

= **ACTION:** Develop and implement a communication plan, targeting the property sector in the GE area

Financial contributions

- Consider the appropriateness of planning mechanisms to capture financial contributions on a local authority basis towards increasing the connectivity of and between areas. These options primarily concern the Community Infrastructure Levy or Section 106 Agreements.

= **ACTION:** Formulate an approach towards financial contributions. This needs to link with/integrate with GE digital connectivity policy regarding local authority direct investment/ Joint Venture investment in community fibre infrastructure, discussed further on

16. GEDA Theme 3 (driving investment) vouchers

The issues

- 16.1 Circa 70% of GE's SMEs can access 30 Mbps or more consumer broadband download speeds, via BT's hybrid fibre-copper network or in a few cases, Virgin Media's cable network. This will not meet the needs of all SMEs however. Some will want faster speeds than they can get. Moreover, consumer services suffer from a number of other limitations compared with lease line services (often termed business grade services). Consumer services:
- Are asymmetric, namely the upload speed tends to be a lot less than the download speed and for many businesses, upload is as important as download
 - Suffer from contention i.e. the more people on line, the less bandwidth
 - Do not offer many of the service quality features of business grade services such as limited downtime/ guaranteed repair times and certain transmission features that some internet services require, or perform better on
- 16.2 Unlike consumer services, where the connection cost is minimal, the connection cost for a lease line (business grade service) can be substantial. The telecoms market tends to charge customers for the dig and other connection costs, on top of the standard connection charge. At circa £100 per meter dig cost alone, this means that connection costs can be prohibitive.
- 16.3 Evaluation of the original DCMS voucher scheme found that voucher recipients derived significant functional and financial benefits as a result of faster better broadband and this translated into economic impacts of circa 30% GVA uplift.
- 16.4 The GE SME broadband survey undertaken between November 2017 and January 2018 found similar benefits and economic impact.
- 16.5 The economic return on investment (ERoI) of the original voucher scheme was also high, because of a combination of the significant economic impacts that were achieved coupled with the relative low unit cost of the project.

How to address these

- 16.6 The voucher scheme is designed to address the extra-over cost barrier to SMEs by offering a subsidy, to SMEs, to pay for 'extra-over' connection costs, up to the voucher limit.

Actions to consider taking

- 16.7 GE has already benefited from the first national voucher scheme run by DCMS. See chapter 8 for details of the number of vouchers taken up in GE, the increase in bandwidth and the providers.
- 16.8 We suggest that GE should take every opportunity to secure funding for, and implement additional voucher schemes. There is an immediate opportunity to do so. DCMS's Local Full Fibre Network (LFFN) Programme, launched at the end of 2017 is currently calling for bids from local authorities (and groups of local authorities) for gigabit-capable voucher schemes. The next bidding round is expected in Spring 2018.
- 16.9 GE submitted a bid to the January 2018 round for a gigabit-voucher scheme. We helped GE discuss a number of options and arrived at a proposal comprising 1,000 vouchers. We undertook an economic impact assessment of the proposed scheme, using a cost-benefit analysis methodology that reflects HM Treasury Green Book appraisal guidance, to support the bid. The cost benefit analysis and results are set out below

Economic impact assessment of a proposed 1,000 SME gigabit-capable voucher scheme for GE

- 16.10 GE's proposed gigabit-capable voucher scheme is in response to DCMS's call for bids for the Local Full Fibre Network Programme.

Voucher schemes

- 16.11 Voucher schemes are a 'demand-side', as opposed to a 'supply-side' intervention in the digital connectivity policy arena, in that they provide subsidy to customers, rather than suppliers. Voucher schemes are relatively new in the policy maker's broadband intervention toolkit and originally came about as a response to State aid limitations on intervention in the 'supply-side'. SME voucher schemes do not generally give rise to State aid as long as they are implemented properly. The subsidy, when made available to SMEs, falls within de minimis allowance¹⁰⁹.

Building on DCMS's first voucher scheme

- 16.12 DCMS's call for gigabit-capable voucher scheme builds on substantial earlier experience of the DCMS-sponsored Connection Voucher Scheme¹¹⁰ which ran in UK cities from December 2013 until October 2015, with delivery of new connections allowed until end April 2016. Around 55,000 vouchers for superfast broadband connections were issued to small and medium-sized enterprises (SMEs) during the lifetime of the scheme – 37,000 between April and October 2015

Impacts of voucher schemes

- 16.13 Voucher schemes tend to have a number of impacts:
- The primary impact is one of provision of faster, better broadband to recipients – as a result of the original voucher scheme, new superfast and business grade supplies were made available to SMEs in areas that previously had only offered basic broadband connections. Voucher recipients in Greater London reported a range of benefits from being able to access faster better broadband – sales increases, productivity increases, more effective home and mobile working, increased innovation, for example
 - A secondary impact is extension of the local access network capable of supporting business grade services, such that it becomes more cost effective/ easier for suppliers to provide services to other SMEs in the area, beyond the voucher scheme. In some cases, this resulted in reduced monthly charges for business grade connections
 - Voucher schemes are also indirectly beneficial to the supply chain in that they open up new sales opportunities, attract new suppliers to the market and enable small suppliers to broaden their business models - more than 770 suppliers across the UK won voucher business in the first scheme (out of 864 registered)

Importance of a gigabit-capable voucher scheme to GE

- 16.14 The baseline work carried out for the GE digital connectivity strategy shows that there is very little if any independent local access fibre network in the area, hence business grade services, requiring fibre-backhaul or high grade wireless point to point services, are likely to be expensive because of higher connection costs due to longer 'digs' and higher prices due to limited competition.

¹⁰⁹ The European Commission considers that public funding to a single recipient of up to €200,000 over a 3 year fiscal period has a negligible impact on trade and competition, and does not require notification

¹¹⁰ Managed by Broadband Delivery UK, a delivery unit within the Department for Culture, Media and Sport

- 16.15 Moreover, circa 30% of SMEs in the GE area cannot access 30 Mbps or more consumer broadband download speeds and 10% are unable to access 10 Mbps or more. There are pockets of poor consumer broadband provision in the urban areas, but poor provision is particularly acute in the more rural areas. The GE SME broadband survey undertaken between November 2017 and January 2018, recorded significant dissatisfaction with services, resulting in lost sales (turnover), poorer productivity and reduced innovation. Responding firms, on average, felt that availability of better faster broadband would boost sales and improve productivity by a total of 30-40%.
- 16.16 A gigabit-capable voucher scheme is also important to GE in its pursuit of the Local Full Fibre Network objectives. A voucher scheme is identified as a key policy tool by the GE digital connectivity strategy in enabling and driving increased investment in competitive local full fibre access network. A voucher scheme is seen as an integral part of a package of measures proposed by the GE digital connectivity strategy to achieve this, alongside other measures such as reducing regulatory and administrative barriers to telecoms infrastructure investment; encouraging new development sites to ensure they are 'fibre-ready' and leveraging local public-sector connectivity spend, publicly owned network infrastructure, sites and premises.

Scale and focus of the proposed scheme

- 16.17 The proposed scheme is for 1,000 vouchers, targeting 5% of the SME community.

Costs of the scheme

- 16.18 The cost of the proposed scheme has been estimated on the following basis:
- Connection costs for a giga-bit capable scheme are likely to be significantly higher than for the original DCMS national voucher scheme which included a high proportion of DSL connections. By definition, a high proportion of connections will be fibre-based in order to be gigabit-capable.
 - Some applicants are likely to face higher connection costs than others, depending on distance to the PoP and/or availability or otherwise of point to point wireless. We don't want to exclude those facing higher costs from this scheme. Therefore rather than setting a single maximum voucher value, we have modelled a mix of values as shown in the Figure below.
- 16.19 Figure 16.1 shows how we have estimated the cost of the voucher scheme, allowing for a range of voucher costs.

Figure 16.1 Costs of the proposed voucher scheme

Cost of the scheme	Target number	voucher value	Cost
High cost	600	3,000	1,800,000
Medium cost	200	2,000	400,000
Low cost	200	1,000	200,000
Total	1,000		2,400,000

Net cost

- 16.20 Figure 16.2 sets out the net cost of the scheme taking account of anticipated take-up timing. In this estimate we assume:
- A two year take up period, allowing for a year set up, marketing, application and processing – and that 30% of vouchers are taken up in year-2 and 45% in year-3
 - We have therefore assumed that a total of 95% of possible vouchers are taken up with 5% still at application stage at the end-date of the scheme. This reflects experience of the original DCMS voucher scheme.

Figure 16.2 Net costs of the voucher scheme		yr1	yr2	yr3	Total	NPV at 3.5%
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Scheme costs						
Take up			30%	45%	95%	
Number of vouchers	1,000		300	450	950	
Cost per voucher - average	2,400		720,000	1,080,000	2,280,000	2,211,563
			35%	55%	100%	
Scheme administration/promotion and demand aggregation	10%	228,000	79,800	125,400	228,000	222,243
Total			799,800	1,205,400	2,508,000	2,433,807

Economic impact and EROI of the proposed scheme

- 16.21 To estimate the net additional economic benefits of the proposed voucher scheme to the GE economy and the Economic Return on Investment (EROI), we have applied the same methodology as used in the London voucher scheme evaluation.

Methodology

- 16.22 The methodology is based on HM Treasury Green Book project appraisal guidance.
- 16.23 The calculations comprise the following steps:
- Calculate the scale of financial and economic benefits of faster better broadband to GE SMEs, based on the GE SME broadband survey undertaken during November 2017 and January 2018. Circa 200 firms responded. A summary of the results is provided in the appendices.
 - Convert the economic benefits from gross to net additional, allowing for deadweight, displacement and leakage.
 - Undertake a cost-benefit assessment, comprising:
 - = Benefits assessment - modelling the net additional economic benefits of the proposed voucher scheme programme over a 10-year period, using cost-benefit analysis methodology, which takes account of timing of take up – focus on the two primary metrics of sales increase and productivity increase (resulting from staff time saving), both expressed as GVA¹¹¹, added together, allowing for a degree of overlap
 - = Cost assessment – modelling the additional tariff costs to beneficiary SMEs
 - = Calculating the net benefit (GVA uplift less additional tariff costs (NPV at 3.5% over 10 years))
 - Calculation of Economic Return on Investment (EROI) by dividing the NPV of net benefits by grant project costs.

Financial/ economic benefits to firms of faster better broadband

- 16.24 The GE SME broadband survey identifies a range of functional and financial benefits that SMEs anticipate they will derive from access to faster better broadband. We have focussed on two for the purposes of estimating the economic impact of the voucher scheme:
- Sales (turnover) increase (converted to GVA) – average sales increases anticipated to by firms to derive from faster better broadband are circa 20%
 - Productivity increase (principally anticipated staff time saving) (monetised as GVA) – average productivity increases anticipated by firms to derive from faster better broadband are circa 20%
- 16.25 Figure 16.3 provides further detail. Sales increase and productivity gains are calculated for three groups of responding firms, based on size (turnover) – all respondents, those with a turnover up to £5m and

¹¹¹ Gross Value Added

those with a turnover up to £1m. The uplifts vary depending on size of firm. We have based the analysis on the mid-category – respondents with a turnover up to £5m.

Figure 16.3 GE SME Broadband Survey - analysis			
Sales increase and time saving as a result of better broadband			
Sales increase (as a % current TO)			
	All	SME (up to £5m TO)	Micro (up to £1m TO)
Number analyzed	97	91	82
% increase	13%	20%	20%
Expressed as % of current £ TO	112,345	92,830	51,189
Time savings (as a % current TO)			
	All	SME (up to £5m TO)	Micro (up to £1m TO)
Number analyzed	98	93	83
% saving per employee per year	16%	20%	19%
Expressed as % of current £ TO	153,378	116,462	67,241

Gross to net adjustment

16.26 Figure 16.4 shows how we have converted gross turnover and time savings benefits into net additional benefits, allowing for:

- Attribution – proportion of benefits that are attributable to faster better broadband – the survey suggests 100% attribution but to err on the side of caution we have assumed a default 90%
- Deadweight – the proportion of the benefits that would have occurred anyway – there is no evidence of deadweight but to err on the side of caution, we have assumed a default 10%
- Displacement – the proportion of additional turnover that derives from sales of other local businesses - the survey does not provide any evidence relevant to judging displacement, hence we have made a judgement and allowed for 30% displacement. Displacement does not apply to time saving benefits
- Leakage – leakage of the sales/ time savings benefits outside of the GE area – on the assumption that all SMEs benefiting from vouchers will be in the GE area, we have assumed zero leakage
- Multiplier affects – often termed supplier and consumption benefits e.g. increased spending by beneficiary local firms in the local area stimulates further growth and increased spending of better paid/ additional employees of beneficiary firms in the local area also stimulates further growth. We have adopted an average urban multiplier of 1.25

Figure 16.4 Net additionality adjustment						
	Gross	Attribution	Deadweight	Displacement	Leakage	Multiplier
Sales		90%	10%	30%	0%	1.25
SME (up to £5m TO)	92,830	83,547	75,192	52,634	52,634	65,793
Time saving		90%	10%	0%	0%	1.00
SME (up to £5m TO)	116,462	104,816	94,335	94,335	94,335	94,335

Estimated voucher scheme impacts – 10-year NPV (at 3.5% discount rate)

16.27 Figure 16.5 shows the calculations used to estimate the Net Present Value (NPV) of the sales increase anticipated to derive from SMEs securing faster better broadband through the voucher scheme.

Figure 16.5: NPV of anticipated sales increase and time savings that derives from voucher scheme

		yr1	yr2	yr3	yr4	yr5	yr6 ¹¹²	Total	NPV at 3.5%
Economic impact									
Sales increase (GVA uplift)									
Impact lag	yr. 1 take up	30%	30%	30%	10%			100%	
	yr. 2 take up		30%	30%	30%	10%		100%	
	yr. 3 take up			30%	30%	30%	10%	100%	
	yr. 1 take up	300	90	90	30	0	0	300	
	yr. 2 take up	450	0	135	135	45	0	450	
	yr. 3 take up	200	0	0	60	60	20	200	
Sales increase - per firm (SME up to £5m TO)	65,793								
GVA conversion 60/40	40%								
GVA increase	26,317								
GVA uplift per year take up	yr. 1 take up	2,368,549	2,368,549	2,368,549	789,516	-	-	7,895,163	7,580,167
	yr. 2 take up	-	3,552,824	3,552,824	3,552,824	1,184,275	-	11,842,745	10,985,749
	yr. 3 take up	-	-	1,579,033	1,579,033	1,579,033	526,344	5,263,442	4,717,444
Total		2,368,549	5,921,373	7,500,405	5,921,373	2,763,307	526,344	25,001,351	23,283,360
Time saving (GVA uplift)									
Time saving - per firm (SME up to £5m TO)	94,335								
Conversion to GVA (allowing for effectiveness of utilisation of saved time)	60%								
GVA increase	56,601								
GVA uplift per year take up	yr. 1 take up	5,094,064	5,094,064	5,094,064	1,698,021	-	-	16,980,213	16,302,746
	yr. 2 take up	-	7,641,096	7,641,096	7,641,096	2,547,032	-	25,470,319	23,627,168
	yr. 3 take up	-	-	3,396,043	3,396,043	3,396,043	1,132,014	11,320,142	10,145,858
Total		5,094,064	12,735,160	16,131,202	12,735,160	5,943,075	1,132,014	53,770,674	50,075,772
Total GVA uplift derived from sales increase + time saving		7,462,613	18,656,532	23,631,608	18,656,532	8,706,382	1,658,358	78,772,025	73,359,132

Estimated costs to business

16.28 Figure 16.6. shows the estimated cost to businesses of the voucher scheme. The principal cost to voucher recipients is an increased annual tariff. The voucher scheme does not cover tariff costs, only the connection costs. We have assumed an average additional annual tariff of £360.

Figure 16.6: Cost to businesses of the voucher scheme e.g. increased annual tariff

		yr1	yr2	yr3	yr4	113 ...	yr10	Total	NPV at 3.5%
Costs to beneficiary firms									
Increased tariffs									
Assumed average increase tariff per firm pa	360								
tail off		100%	100%	100%	100%		0%		
		360	360	360	360		0		
	Yr. 1 take up	300							
	Yr. 2 take up	450							
	Yr. 3 take up	200							
	Yr. 1 take up		108,000	108,000	108,000		-	572,400	530,403
	Yr. 2 take up			162,000	162,000		-	858,600	768,700
	Yr. 3 take up				72,000		-	381,600	341,644
Total tariff		108,000	270,000	342,000	342,000		-	1,812,600	1,640,746

¹¹² Note, we have only shown the first 6 years of the 10-year NPV cashflow

¹¹³ Note, we have only shown the first 3 years of the 10-year NPV cash flow

Net benefit

16.29 Figure 16.7 shows the net benefits of the voucher scheme

Figure 16.7: Net benefit (sales+time savings benefits) less costs to business (of increased tariff)

	yr1	yr2	yr3	yr4	yr5		Total	NPV at 3.5%
Net benefit								
	7,354,613	18,386,532	23,289,608	18,314,532	8,396,782		76,959,425	71,718,385

ERol

16.30 Figure 14.8 shows the estimated ERol of the voucher scheme in terms of GVA leverage i.e. Net additional £ GVA per £1 grant. We calculated an ERol of 31.46. This represents a very positive return on investment.

Figure 16.8: ERol	
Total capital cost (voucher cost)	2,280,000
% Grant	100%
Grant	2,280,000
ERol	31.46

16.31 We have not taken into account the wider impacts of voucher schemes, such as:

- Increased investment in local access network, enabling more SMEs to access services at lower connection costs post the voucher scheme
- Increased competition and potential reduced tariffs
- Growth of the supply chain, particularly the smaller suppliers.

16.32 These are valid additional impacts, which if monetised, would increase the GVA leverage ratio further.

17. GEDA: Theme 4 (driving investment) local authority leverage

4a. Leveraging local PSN and assets – preparing a business case and funding bid

- 17.1 DCMS's launch of the Local Full Fibre Network programme (LFFN) fund and call for Expressions of Interest late last year included a list of the types of project that the programme would fund. One such set of projects involves local authorities in taking an 'active role' in investment in new local full fibre networks. This, as noted earlier in the report where we discuss national policy, marks a notable shift in policy, which, hitherto, did not encourage local authorities to engage in investment in, or operation of local access networks. Previously, policy sought to leave this to the industry. This shift in policy means that GE local authorities should, at least consider options open to them, to engage in delivery of local full fibre network rollout, especially as these options could potentially attract grant funding.
- 17.2 Several alternative approaches are presented by DCMS's LFFN programme bidding guidance. The approaches put forward can be grouped under two broad headings, which offer two contrasting forms of intervention option for local authorities:
- **Anchor-tenancy/aggregator route** – creating a giant contract to offer to the telecoms market with the aim of achieving cost savings + additional local full fibre network rollout delivered by the winning bidder
 - = This route involves bundling up local authority annual connectivity spend¹¹⁴, with publicly owned network (e.g. CCTV network, traffic control network and any redundant/unused duct), with access to public sites and buildings (to sight masts, dishes, antenna) – and offering these to the market via an appropriate tendering process.
 - = A single, or possibly a consortium of telcos will win the bid – potential bidders include the incumbents (BT/Open Reach; Virgin Media); the new altnets, and possibly others). The DCMS guidance cites CityFibre's business model as the example¹¹⁵.
 - = The twin objectives are (a) to save local authorities revenue spend by getting a better deal, through bundling (aggregating) annual connectivity spend and (b) to secure commitment from the winning bidder to build out local access fibre network to housing and business areas alongside its core network
 - **Co-operative/ Trust - shared ownership route** – this involves one or more local authorities along with other local partners (NHS, schools, colleges etc), possibly including one or more telcos, establish a new vehicle (joint venture, co-operative, trust) to build, own, manage and operate (on a fully open access basis), an expanding full fibre local access network
 - = This involves each partner to the vehicle injecting one of more of the following: assets (as above: local authority revenue spend on digital connectivity; publicly owned network (CCTV, traffic management, redundant duct); access to public land and buildings to site mast etc), revenue spend on digital connectivity, capital investment and grant (e.g. LFFN funding bid)
 - = The vehicle then extends its core network, as funding is available, and operates it on an open access wholesale basis (offering duct, dark fibre), enabling both its members and any and all other carriers to run ethernet and retail services over the network, and, to add to the network

¹¹⁴ This refers to the annual spending of local authorities and other public bodies on digital connectivity services – usually comprising point-to-point lease-line services plus other forms of connectivity

¹¹⁵ See the appendices to this report for a full list of other altnets and their recent deployments

(e.g. local spurs to housing and business areas), on condition that any network additions are also operated on an open access basis

- = The benefits of this are (a) reduced local authority revenue spend on digital connectivity (because a co-operative network can provide services to its partners at lower cost) (b) increased rollout of local access network full fibre operated on an open access basis (c) revenue return (income) to co-operative/trust partners
- = The DCMS guidance cites the Tameside trust as an example. The Tameside approach was designed by CBN¹¹⁶ and is being implemented with help from CBN members. It's termed 'the thin-layer' model. Appendix R provides further details of Tameside's 'thin layer' model

Which route is best, which route is best for GE, or, should GE not seek to take part in either route but instead focus on traditional models of facilitating/encouraging continued incumbent investment?

- 17.3 Clearly, this is all very new, in every sense of the word, in terms of policy, in terms of new roles for local authorities, in terms of potential risks and rewards for local authorities and other public sector partners, in terms of how well either route will work, to what extent LFFN programme and other central Government funding will be secured, and to what extent either route will deliver the expected outputs and outcomes....and all in the context of ever tightening local authority budgets/ resources
- 17.4 Both routes are very much at pilot stage. This is as much an experiment by Government as it is for local partners. The current funding on offer, although it seems generous (£200m), is a drop in the ocean. The scale of investment required to fully deploy local full fibre is massive. The funding is, we believe, intended as a catalyst to stimulate and provide a test-bed for alternative intervention routes to the established 'traditional' route of gap funding the incumbents.
- 17.5 The capacity of the new altnets to roll their aggregator business models out across the whole country is still to be tested – the sector, although increasingly well-funded via infrastructure funding from the capital markets, is nevertheless embryonic; the extent to which the new altnets are able to invest in local full fibre off network is yet to be fully tested; indeed, can full fibre across the whole country really be achieved without massive investment from the incumbents. And if the new altnet business model is genuinely scalable in a sustainable way, will the end result actually be much different from what the incumbents would have done
- 17.6 Equally, the capacity, the ability, the political will of local authorities and other public-sector partners to engage in setting up, investing in, and being party to shared co-operative new vehicles offering duct/dark fibre, is also still to be tested, as are the risks and exposure to partners.
- 17.7 No one knows the answers to these questions. The issue for GE is does it want to take part in an experiment – in piloting possible new approaches.

Recommendation

- 17.8 As a first step, GE partners need to consider the options and decide which route, if any, to follow.
- 17.9 We suggest this is considered in the context of the following over-arching points, derived in part from the GE baseline work set out earlier on in this report:
- A high proportion of households and SMEs across GE now have reasonable consumer broadband services – there are gaps in rural areas and some urban not-spots, but GE overall is now relatively well served with superfast – 30-50 Mbps download consumer broadband

¹¹⁶ Community Broadband Network

- Most SMEs and households do not currently need anywhere near gigabit-capable connectivity – which is the Government’s rationale for focussing on local full fibre network deployment – but it will only be a matter of time before they do
 - It takes a long time to deploy a new network infrastructure such as extensive local access full fibre – other parts of the world have already started – Ofcom suggests that the UK should start, or risk being left behind. Moreover, GESP is all about looking forward, looking to the future and ensuring that GE is ‘future-ready’. This ought to include being ‘fibre-ready’
 - The Government, for the first time, is offering local authorities and other local partners (NHS, schools, colleges), the opportunity to come together, to bid for money and to take action, to pilot one or more new methods of local intervention with the aim of stimulating investment in local full fibre. This is no more than a start of what will be a long road – a 10-15-year investment programme at least, if started now, if funding is available
 - The consensus is that the incumbents will invest in more local full fibre network and in its near equivalent (which in BT’s case is G-Fast), but that their investment programmes are national, such that GE is not guaranteed to get as much investment as it would like; moreover rural areas are likely to be left out, or left till last again – and – SMEs may only be offered more expensive lease line services rather than gigabit consumer services
 - So, without additional intervention – such as that currently on offer from DCMS under the local full fibre network programme – this may well be GE’s lot
- 17.10 The decision on whether to take this opportunity to take local action, along with its risks and commitments, or not, must be a local political decision. Before that decision can be taken, GE will need more information however.
- 17.11 Much of what might be achieved via the aggregation or local co-op route is subject to future negotiation/deals – hence we suggest that the first step to ‘getting more information’ is what is termed in the industry as ‘soft-market testing’. This means talking to potential partners to explore who is interested in what, who will offer what and what the likely costs, outcomes and impacts might be.
- 17.12 Following soft market testing, it will be possible to formulate high level options and to prepare outline businesses cases for each, including cost benefit analysis to allow comparison of the options
- 17.13 Appendix Q sets out the sequence of assessments and steps involved in preparing a suitable business case for such options - reflecting HM Treasury Green Book project appraisal guidance
- 17.14 This will then provide a reasonably robust basis on which a local political decision can be made regarding whether to take action and if so, which option.
- 17.15 Some difficult trade-offs will need to be considered, for example:
- Whether to focus on cost saving or network rollout
 - Whether to focus on rollout in urban areas as this will generate the strongest business case and the highest economic returns, or whether to focus on the rural areas in order to address spatial exclusion
- 17.16 The options appraisal process will help at least frame the choices, but the final decision needs to be a political one
- 17.17 This would then form the basis of a 3rd round local full fibre network programme funding bid

Rural initiatives

4b.1 Work with ‘excluded’ local communities to explore DIY options.

- 17.18 One approach of the ‘do-it-yourself’ model is the Swedish approach where the municipality funds fibre rollout along the principal highways and residents/businesses/farms either side dig their own ducts and lay their own fibre, acting collectively, and using farm trenching tools etc. Closer to home, Cybermoor and BARN¹¹⁷ are good examples. A local approach is likely to be necessary to provide access to ultrafast services in the more remote rural areas because of the high cost of rollout of traditional networks. Explore alternative business models – such as, community and cooperatively owned networks – and different approaches to infrastructure deployment, including ‘dig it yourself.’ In the US and Canada, broadband delivery in rural areas is often the responsibility of local power cooperatives – consider a wider range of utilities partnerships.

4c.1. A rural wide initiative

Need for a rural wide initiative

- 17.19 Rural connectivity issues include:
- Remaining super-fast (NGA gaps)
 - Uncertainty over the effectiveness and timing of rollout out of a national 10 Mbps Universal Service Obligation for broadband
 - Significant gaps in mobile coverage (4G)
 - Lack of clarity over what form 5G will take and
 - Need for substantial fibre backhaul.
- 17.20 This would suggest that the main policy priority for GE’s rural areas is to explore measures that will ensure wide deployment of local fibre networks. This will provide the necessary backhaul for 5G, it will help address any remaining superfast gaps...and...it will help ensure that rural areas are not left out as the urban areas pursue local full fibre network deployment.

Major investment will be required – which by the usual rules will not be deemed ‘cost effective.’

- 17.21 The ‘traditional business models’ of the incumbents (and even of the newly emerging altnets) which are urban focussed, are unlikely to work – investing in deep fibre in rural areas will be deemed not cost effective. This suggests that the market’s traditional (and new) approaches, even with substantial Government gap funding, are unlikely to work fully or at all; this suggests that alternative, more radical, business models need to be considered. This is only likely to happen if the local authorities and local communities take pro-active action to do this.

Case for a rural-wide theme

- 17.22 From this we conclude that there is a case for a rural theme in the GE digital connectivity strategy, either as stand-alone or as a continuation of urban themes in the strategy - no matter how much funding might be available from central government and/or the incumbents and altnets for investment in local fibre networks in rural areas, it is very likely to fall short of the total required. Without ‘more radical initiatives at the local level’, a similar pattern to previous rural deployments seems likely, namely patch-work, uneven and delayed deployments with a proportion being left out.

Time for more radical models

- 17.23 For these reasons and given that Government for the first time is suggesting that local authorities and local communities play a much more prominent, if not lead role, in initiating and funding local fibre

¹¹⁷ See Chapter on rural theme for further details

deployments, we see the time being right to explore new, alternative local fibre funding, ownership and operational models, perhaps replicating earlier successful projects such as Cybermoor/B4RN or at least drawing in these.

- 17.24 Certain of the project themes being promoted by DCMS's current Local Full Fibre Programme competition would seem to be particularly pertinent. For example, the GE digital connectivity strategy could promote a public-private-community based fibre investment, build and manage vehicle, that leverages existing public- sector connectivity spend, any publicly own networks, LFFN grant and institutional investment funding, enabled by the National Infrastructure Commission's fund managers (e.g. Amber)
- 17.25 There would be trade-offs for such a project – funding new dig in rural areas, with the consequent higher unit costs, would mean there is less funding available for urban areas, but an urban-rural model will enable cross subsidy to be explored.
- 17.26 The options are complex and need to be considered by stakeholders; a project team will need to be assembled (comprising local authority officers, other stakeholder organisations and with specialist consultancy support), a business model and options appraisal will need to be prepared/undertaken, as part of the LFFN bidding process. The amount of work involved for just the urban element is substantial; including the rural element will increase the level of preparatory work required significantly. The time required to prepare a business case and options appraisal, including time for consultation and discussion is in our view at least 3 months.

18. GEDA Theme 5 – supporting/cross-cutting measures

5a.1 Local digital exchange (LDX) – establishing one or more local digital exchanges at digital skills training centre (college/academy etc)

- 18.1 A digital exchange is a building/space in which a number of fibre networks meet and have the opportunity to interconnect/exchange traffic and access low cost transit/ long-haul bandwidth¹¹⁸. In addition, DX's often also include 'hosting facilities' – i.e. racks housing banks of servers for data storage. And, because some specialist digital technology firms find it advantageous to be very close to their 'racks and servers' to enable easy-hands-on access, a cluster of digital businesses often builds up around a DX.
- 18.2 The first DX's evolved in London, Edinburgh and Manchester. London's DX is located in the docklands, Manchester's in Manchester Science Park and Edinburgh's in the Pulsant data centre in Edinburgh and the DataVita facility east of Glasgow.
- 18.3 A critical feature of a DX is that it is in a neutral place rather than in a building/space owned by one carrier. DX's tend to be found in natural co-location data centre facilities therefore. The types of ownership/management model that the early digital exchanges evolved were also models reflecting neutral, shared governance and ownership, such as a cooperative.
- 18.4 There have been a number of attempts to create regional/local digital exchanges. For example, the RDAs funded a project to do so in the Northeast and Plymouth City Council funded a broadband strategy study which explored the scope of establishing a local DX in a suitable location in Plymouth.
- 18.5 More recently, a publicly funded initiative established a 'local' DX in Brighton
- 18.6 We suggest that the GE digital connectivity strategy includes proposals to establish one or more local DXs in suitable locations, modelled on Brighton in terms of location, ownership and management. The cost of establishing the Brighton IX was relatively minimal
- 18.7 The features of a GE Local DX would therefore comprise:
- A dedicated server room, in a low flood risk location, with appropriate security, primary and backup power, appropriate fire suppression and other technical features – i.e. a mini data centre
 - Located in or close to a digital skills college/ training facility, or within an existing cluster of digital technology firms
 - With technology start-up/ micro business desk space/ office space available in or close by on flexible terms with technical/ business support available
- = Action – explore locational options and potential hosts/partners
- 18.8 See Appendix M for further details

5b.1 Wider digital skills plan

- 18.9 Digital skills are also important if businesses and households are to optimise digital connectivity. The productivity benefits of delivering world class digital connectivity will not be realised unless professionals and users are effectively upskilled.
- 18.10 Digital skills divide into two broad categories - professional and user skills – both are important. Gaps in either category of digital skills will hamper optimisation of digital connectivity.

¹¹⁸ Low cost transit over the national/international backbone

- 18.11 Mapping and addressing digital skills needs/gaps and solutions is a complex topic, requiring its own dedicated strategy, that sits alongside a digital connectivity strategy.
- 18.12 The digital connectivity strategy therefor does not attempt to directly address digital skills needs and solutions, although there will be overlap between the two strategies in places. For example, the digital connectivity strategy proposed creation of a digital exchange (DX), located ideally at or linked to a digital college or other digital skills centre of excellence.
- 18.13 A digital skills strategy could embrace:
- digital upskilling and plain English myth busting within businesses locally, to ensure all have the opportunity to improve their competitiveness in an increasingly digital economy;
 - issues in schools – including whether all schools teach IT and have a qualified IT teacher; the extent to which schools include programming where they do teach IT;
 - issues at the level of the 6th form – some areas are establishing dedicated digital colleges as centres of excellence;
 - issues at HEI¹¹⁹ level – including the extent of students pursuing digital skills courses e.g. computing/IT/cyber security; how relevant these courses are to employers' needs; graduate retention in the local economy; the extent to which all other students take IT/digital skills modules; access to digital degree apprenticeships;
 - level and appropriateness of IT user skills – in SMEs, in public sector, in the wider community;
 - availability of IT support to the local economy – nature, scale and appropriateness of the IT support sector in the economy – the local computer shops through to access to main stream software company support; and
 - integration between digital skills and innovation/creativity – the nature and strength of the digital and creative economy, its innovation eco-systems, supporting infrastructure such as digital hubs, digital incubators.
- 18.14 Digital skills solutions are partly dependant on better use of main stream educational and apprenticeship budgets but also require dedicated local funding to support local initiatives.
- = Action – workshop with partners/stakeholders with an interest in digital skills to explore the need/ opportunity/ scope for a digital skills strategy

¹¹⁹ Higher Education Institute

19. GEDA Theme 6: Future technologies and opportunities

6a.1 Digital strategy for new developments proposed by GESP

- 19.1 The GESP will propose a number of large scale new developments, some of which may potentially be delivered as new settlements. The ambition is that these will be operated as 'smart settlements' optimising every and all aspects of relevant technology. This will require provision of appropriate digital connectivity, which in turn will require provision of appropriate digital connectivity infrastructure – principally extensive local full fibre network infrastructure. The new settlements also provide a unique opportunity to install such infrastructure, at the design and build stage, alongside provision of other utilities, at marginal cost
- 19.2 Inclusion of these objectives in the GESP will be an important step in helping to ensure these objectives are delivered. The GESP could also include:
- A worked example of an illustrative new settlement – indicating the types and quantum of digital connectivity likely to be needed to support the needs of a 'smart' new settlement
 - Specific examples of the connectivity needs of actual proposed allocations.
- 19.3 Earlier in this report (chapter 8), we set out the results of an assessment of an illustrative new settlement comprising 10,000 new homes, demonstrating the full spectrum of digital connectivity needs - fixed, mobile and IoT.
- 19.4 The sequence of steps involved in this assessment, as set out in chapter 8, included:
- Identification of the nature and scale of the proposed development e.g. number and size of new households, scale and type of proposed business space, number of businesses by size (employment) this will accommodate, estimated peak vehicle movements and estimated number of IoT devices
 - Identification of future unit bandwidth requirements – for fixed line, for mobile (5G), for assisted vehicles and for wider IoT
 - Calculation of the total bandwidth capacity required
 - Recommended network technology/architecture required to provide the total bandwidth capacity required

6b1: Piloting and demonstrating 5G

- 19.5 Actions for GE to consider undertaking in the mobile arena include:
- Addressing current 4G coverage gaps, particularly in the rural areas***
- 19.6 We identify 4 potential action areas to consider in discussion/ consultation with the MNOs¹²⁰
- Mapping 4G coverage gaps at a sufficiently granular level to be useful – including overlaying with land use maps, public land ownership maps. This depends on how fast Ofcom can get MNOs to share network data
 - Further reduction of land use planning obstacles to installation of new masts/towers – GE should explore this now

¹²⁰ Mobile network operators

- Gap funding MNO network rollout – currently prevented by EC State aid regulations, so it's a case of waiting to see if these regulations continue to apply post-Brexit. The current thinking is that they are likely to
- Community action – investment by households and businesses in mobile phone signal repeaters. This is a low-cost way of extending the 4G network. It is subject to regulation however. Ofcom has just completed a review of the regulation and decided to permit use of repeaters by households only, but only within the house, not between properties. So, at present, this option is not available

Preparing the way for 5G deployment, anticipated to take place in the next decade

19.7 We identify a two stage 5G strategy for GESP

Taking an active flagship role in helping develop 5G technology and its applications

- Paving the way for 5G rollout, by making GESP more investment ready for 5G
- Taking an active flagship role in helping develop 5G technology and its applications
- Government and intermediary agencies have issued a number of competitive funding rounds focussed on pilot programmes. GESP as far as we are aware has not bid into any of these as yet. It should seek to do so in the next available funding rounds.
- Examples of the types of pilot/demonstrator studies that GESP could seek to pursue include:
 - = 5G and smart settlements - focussing on new development proposed through the GESP
 - = 5G and one or several industry-sector applications
 - = 5G and precision agriculture

19.8 Planning - GESP needs to address potential planning hurdles to masts/dish sites - Planning regulations are a key factor influencing a network infrastructure provider's ability to expand its network, as they govern where sites can be built and the physical appearance of the equipment that can be installed on such sites. The deployment of 5G will require a significant increase in the number of small radio cells - likely to be located on street furniture, the sides of buildings etc. - in order to facilitate the requirements of 5G networks. Therefore, flexible and fit for purpose planning regulations will be required to support the deployment of 5G networks.

19.9 Fibre backhaul - actively implement all feasible measures possible to support and enable large scale investment in local full fibre networks across GESP, including in the rural areas

6b.2 The Connected Farm

19.10 Very few, if any, local digital strategies, when they address rural connectivity issues, think about connectivity across a farm. At best, issues regarding connectivity to farm buildings are lumped in with wider rural connectivity issues e.g. poor connectivity to rural households and rural SMEs.

19.11 Digital connectivity, from farm buildings, across fields and within the farm yard, is now being recognised as both an opportunity and an issue. Connectivity across fields enables 'precision farming' which helps farmers increase yield, reduce wastage, reduce costs and reduce environmental pollution. Similar, connectivity across the farm yard enables deployment of a variety of sensors (the Internet of Things) that generates similar benefits.

19.12 The benefits to farmer's businesses are substantial

19.13 The two issues farmers face in deploying effective precision farming is

- Connectivity across fields

- Connectivity to farm buildings (providing the backhaul)

Connectivity across fields

19.14 Technologies being investigated include

- RTK¹²¹ – well established but expensive and requires backhaul to farm buildings
- Wi-Fi – coverage issues, being further investigated
- White Space – newly available spectrum,¹²² being investigated
- 5G – does not exist yet but could play a key role
- Mobile satellite connectivity via a mobile VSat – too expensive at present but rapid technology development is bringing the cost down

19.15 Innovate UK for example is funding a number of pilot studies into the connected farm. Adroit Economics is a partner in one such study, in Yorkshire, that has just completed; we are also partners in a subsequent study, along with Airbus Space and Defence.

19.16 The subject has also been included in at least one rural 5G demonstrator funding bid

Connectivity to farm buildings

19.17 The issues are the same as for connectivity to any rural building e.g. remote location, distance from existing BT copper network, high costs of upgrading network, cost prohibitive to new network providers.

Why think about the connected farm in a digital connectivity strategy?

19.18 The opportunity and the needs of the connected farm adds a new dimension to rural connectivity issues

- Once connectivity issues across fields are resolved, back haul to farm buildings will become very important
- The benefits of precision farming will provide a stronger rationale and business case for improving backhaul to farm buildings, adding further impetus to rural connectivity needs and possible solutions

Immediate opportunity

19.19 The immediate opportunity for GESP is to tap into the growing volume of funds being made available by the UK Government to support precision farming, agricultural connectivity and 5G

19.20 GESP should seek to establish a rural connectivity pilot project that acts as a 5G test bed but integrates connectivity farm issues/opportunities. This will raise the awareness of the opportunities and issues amongst GE farming communities, if/when the test bed pilot studies are successful, it will enable GE to become an early adopter.

19.21 What would success look like:

¹²¹ Real Time Kinematic (RTK) satellite navigation is a technique used to enhance the precision of position data derived from satellite-based positioning systems (global navigation satellite systems, GNSS) such as GPS, GLONASS, Galileo, and BeiDou. It is used extensively by large cereal farms to aid 'precision farming'

¹²² electromagnetic spectrum vacated by TV since the switch to digital

- All farms can access sufficient backhaul – precision farming bandwidth needs are relatively low – circa 10 Mbps, but the service needs to be symmetric. In GE, many farmers report very poor broadband speeds, significant instability and down time
- 4G or equivalent bandwidth is available across all fields, using 4/5G technologies in combination with other local transition technologies. Our best guess is that we are looking at a 5-year time horizon at least to resolve this

19.22 What this will enable

- It will enable those farms currently using RTK to save significant costs (RTK is relatively expensive)
- It will enable those farms currently not using RTK to invest in and use more cost-effective precision farming services

6c.1 Establish a digital connectivity technology futures/ foresight watch function

- 19.23 This could be housed within the strategy team in order to identify emerging new technologies and applications that the local authorities can feasibly bid for funding for and take part in pilots/ demonstrators.

20. Immediate opportunities

20.1 The measures proposed in theme one could begin to be implemented immediately by the GESP authorities to make the area more 'investment-ready', immediately. These comprise:

- establishing a developer broadband forum/ working group;
- soft market testing/ consultation with telecoms suppliers;
- implement the sequence of steps required to embed digital connectivity strategy objectives in land use planning policy, in the GESP and in the local plans/ SPGs; and
- establishing a cross-authority working group to address licensing/regulation of street/ highways works and streamlined planning processes for telecoms infrastructure.

20.2 Measures to support theme 2 - **assisting, facilitating and co-funding telecoms infrastructure investment**, however, depend on available funding.

- The immediate opportunity is to submit a full bid (in Spring 2018) to DCMS's Local Full Fibre Network programme. We understand that DCMS may favour bids by multi-authorities that reflect coherent geographies. The GESP area as a whole is likely to be more appropriate than individual bids by each local authority for such funding because it encapsulates a city and its environs. The terms of reference for the 2nd round full bid stage were published in December 2018, with a deadline for submission on 24th January. DCMS has indicated that there will be a third round in the Spring ¹²³. A successful bid is likely to be innovative and represent good pilots for future intervention models. Such a pilot will:
 - = deliver significant additional ultra-fast infrastructure;
 - = leverage public sector assets;
 - = attract significant private sector investment;
 - = generate a high return on investment for public funds/ assets; and
 - = be self-sustaining and scalable.
- Monitor the NIC¹²⁴ funds for opportunities.
- Seek to secure 5G pilot funding.
- Seek to secure funding supporting piloting of other 'smart' city or 'smart' settlement opportunities, and associated IoT¹²⁵ opportunities.

Digital action plan – longer term

20.3 The longer-term goal of the digital connectivity strategy is to embed and integrate digital connectivity infrastructure and services at the heart of the GESP's strategic objectives to help steer transformation of GE's economy, jobs and skills; as a place to live and its environment (smart city, smart settlement encompassing smart transport and smart energy).

20.4 Other and related longer-term themes to explore include:

¹²³ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/661364/Challenge_Fund.pdf

¹²⁴ National Infrastructure Commission <https://www.gov.uk/government/organisations/national-infrastructure-commission>

¹²⁵ Internet of Things

- Strategy for a new settlement – digital action plans to be formulated, at planning and design stage for new settlements
- GESp – alternative ownership models – consider implementing one of the ‘alternative public/ private/ community fibre investment, ownership and operational models suggested in the LFFN programme bidding guidance – e.g. the Thin-layer model in Thameside (CBN¹²⁶).

¹²⁶ Community Broadband Network. Shaun Fensom is author of the model and has set it up in Thameside. Shaun is a member of the Adroit Broadband Consortium

21. Implementation

Strategic leadership and effective delivery

21.1 Delivery of the GE digital connectivity strategy needs a leadership group and an executive group:

- An appropriate strategy leadership grouping needs to be established - comprising appropriate/interested senior personnel from within local authorities and other stakeholders - with responsibility for making strategic choices/ prioritisation, and signing-off on these, then commissioning an executive grouping with overall responsibility for ensuring implementation, monitoring and evaluation.
- The executive is likely to comprise key officers with appropriate knowledge/expertise, from within local authority Economic Development teams and strategic planning and also drawn from other stakeholders.

Draw on as much existing local broadband policy expertise as possible

21.2 In our experience, it is important to draw on as much existing local experience, expertise, knowledge and data as possible. The Economic Development team at Devon County Council, engaged with the Connecting Devon and Somerset (CDS) work, appears to be an appropriate source of this.

- CDS are currently focussed on NGA. This strategy focusses on the next paradigm – local full fibre. Accepting this, the knowledge and experience built up by those responsible for the CDS programmes will be invaluable in strategic leadership and executive delivery of the new Local Full Fibre (LFF) paradigm
- Moreover, contrary to the Government’s generalised statement that NGA is done and it’s time to move on to full fibre, our discussions with CDS personnel and others suggest that NGA is not done in Greater Exeter, that substantial gaps remain and that new funding/ programmes are in the process of being drawn up and/or need to be. See Appendix L for further detail and CDS’s proposed plan of action. Hence, the new digital connectivity strategy team will also need to be cognisant of remaining NGA issues and solutions. In short, the team will need to finish the old job and start the new job, and in so doing, addressing any potential conflicts and ensuring optimisation

Stakeholder engagement

21.3 Delivery of aspects of the digital strategy will depend on consultation and engagement

- Developer engagement – establish a developer-forum
- Telecoms industry engagement – one-to-one consultations through to soft market testing when preparing for procurements

Monitoring and review

21.4 Given how fast policy and the funding environment is changing, we recommend that GE’s digital connectivity strategy and its proposed actions are reviewed regularly. New funding streams may become available, moreover the overall thrust and direction of national policy may change, possibly significantly, for example if there is a change of government. It will be important to review the implications for the GE digital connectivity strategy and update key action themes to reflect this.

22. GESP - Planning for digital infrastructure

22.1 This section expands upon the planning themes identified throughout the Digital Connectivity Strategy.

Introduction and planning context

22.2 This digital connectivity strategy has identified that the broadband/digital connectivity aspirations of the emerging GESP should be included within policy. This should be done at the first available opportunity, in order to provide a policy environment that establishes these intentions and requirements at the local and regional level, and to establish a policy environment within which the more detailed proposals can be developed through the emerging plans and guidance.

22.3 Explaining this conclusion, and to provide more detailed recommendations on the appropriate planning interventions that should be incorporated in to GESP and in to the GE local authority development frameworks, this section comprises the following:

- a) **Aims and objectives** – summarising the key purpose and intended outcomes;
- b) **Technical requirements** – summarising the primary types of digital infrastructure to which this section relates;
- c) **Opportunities and challenges for addressing broadband connectivity through the planning system** – identifying the issues that are currently faced, and highlighting opportunities available within the planning regime to address some of these challenges – acknowledging that some of these issues cannot be addressed through the planning system;
- d) **Components of sound and effective planning policies** – identifying the components of a planning policy that will aid developers to ‘buy in’ to the policy objectives, thereby incentivising compliance; and explaining the minimum requirements of any planning policy or planning policy document, including a robust evidence base (which should include and build upon this Digital Connectivity Strategy) and a proper consultation process;
- e) **Planning policy recommendations** – providing a recommendation to include a single, high level policy in the GESP which establishes the overall digital connectivity objectives, and going on to incorporate more detailed planning policies and guidance at the local level; and
- f) **Case studies** – demonstrating the ways in which other authorities have sought to address digital connectivity through planning.

22.4 It should be noted that this note primarily considers interventions targeted at making developments ‘fibre ready’, rather the provision of off-site infrastructure or making the connection itself. Measures to address this wider challenge are addressed through means other than planning, within this digital connectivity strategy.

22.5 As outlined earlier in this report, retrofitting is a significant challenge. As renovations often do not fall within the definition of ‘development’ (to which planning policy and planning permission is relevant), it is often difficult or impossible to require broadband improvements to existing developments. This note therefore pertains to new development but encourages development specifications that support the wider aims of this digital connectivity strategy to allow for market competitiveness and choice, such that upgrades to broadband/digital infrastructure can be more easily facilitated on sites in the future.

a) Aims and objectives

22.6 The aim of this element of the digital connectivity strategy is to enable and accelerate the delivery of full-fibre in and across the area.

- 22.7 Planning policy and guidance can be a strong and effective tool to do this. Its primary objectives should be to:
- 1) reduce barriers (practical and financial) to the installation of, and access to, the fastest broadband speeds for providers and users; and
 - 2) support consumer choice and effective market competition by requiring ducting sufficient to allow more than one provider to service a development.
- 22.8 The planning policy recommendations made in this section seek to ensure that developments are capable of accommodating the digital connectivity technologies to facilitate the achievement of these objectives.
- 22.9 There are a number of different network technologies in common use by the market to provide connectivity to sites.¹²⁷ A wide range of service levels are offered over these, with service level metrics being defined in terms of speed (most commonly upload, but at times download, symmetry, contention, etc.), whilst other metrics include resilience, downtime and stability metrics.
- 22.10 Given this variety, it is recommended that the policy focus should be on the service level/ technology being promoted by current Government digital connectivity policy, with the flexibility to accommodate future technologies as they emerge.¹²⁸ Current national digital connectivity policy objectives would require inclusion of digital connectivity infrastructure that can accommodate ‘full-fibre’ – i.e. ducting i.e. ‘blue/green plastic tubes’ in which fibre optic cable can be blown/pulled (or in which sub-duct can be laid, into which fibre optic cable (e.g. 48/96 core) can be blown/pulled).

b) Technical requirements

- 22.11 In order to achieve the objectives identified above, the infrastructure relevant to planning relates to pre-installation (laying) of duct, at three spatial levels, to enable developments to be ‘gigabit-ready’ i.e. to pre-install, at the construction stage, alongside installation of the other utilities, end-to-end fibre duct, which will be operated on an open-access basis, available to service providers to provide dark fibre/ lit-fibre (e.g. ethernet services) and retail services (such as internet access) to dwellings/ business units on site:
- i. **Off-site:**
 - a. duct from the nearest interconnection points (Points of Presence; ‘PoP’) on existing networks, to interconnection point(s) on the site, providing a connection route (termed ‘backhaul’) to the site;
 - b. where sites require physical resilience, duct is needed from two physically separate PoPs on separate external networks, entering the site at different points and connecting to two separate connection chambers, feeding a resilient on-site ring.
 - ii. **On-site:**
 - a. duct from the site PoP to the building(s) connection chambers; and
 - b. risers from the building interconnection point to each floor (for multi-storey, multi occupancy buildings) with: (a) sufficient capacity (space) to include fibre optic duct/sub

¹²⁷ Fixed (copper, coaxial cable, fibre optic cable); wireless (microwave, Wi-Fi, WiMAX) (point to point, point to multi point); mobile telephony.

¹²⁸ At the time of writing, the focus is very clearly on Local Full Fibre Networks (i.e. ‘fibre to the premises’ or ‘FttP’) as opposed to hybrid combinations of fibre/copper/cable; ensuring that the potential to deliver gigabit-capable services (even if customers at this time do not want or wish to pay for such speeds. In addition, supporting evidence/ rationale provided in the regulator’s current consultation document on local access networks emphasises the need to ensure ‘higher quality services’ are also available (symmetric services, guaranteed minimum bandwidth, stability). These additional features are synonymous with FttP/FttH network architecture.

duct alongside other services/utilities; and (b) sufficient access points providing easy access to digital network installers for installation, maintenance and repair).

c) Opportunities and challenges for addressing broadband connectivity through the planning system

- 22.12 Figure 22.1 provides a summary of some of the existing challenges to delivering broadband improvements within developments, and a discussion of the related opportunities.
- 22.13 The Figure is organised by theme and, whilst many of the points present opportunities to address the challenges, it must be recognised that some of the challenges cannot be reasonably addressed through the planning system. Those challenges are nevertheless included in Figure 22.1 in order to encourage thinking about how these issues can be overcome in other ways.

Figure 22.1 Challenges and opportunities

Challenge	Opportunity
Addressing challenges outside of the planning system - Retrofit cost and service sharing between providers	
In order to fulfil the policy objective, appropriate ducting must not only be funded but must be delivered in order to achieve intended outcomes. Most existing buildings and new build developments do not have the physical capacity to accommodate the cables of more than one provider – and providers often require exclusive access to these cables – both on-site and off-site. This limits consumer choice and market competition. For existing buildings and developments, the challenges to delivery involve barriers to the delivery and shared use of both off-site and some on-site spatial components, which are caused by existing agreements or arrangements between developers and specific infrastructure providers or service operators. However, the planning system cannot require existing developments to update their on-site digital connectivity. Retrofitting existing developments is also costly and therefore a disincentive for managers of existing buildings to upgrade on-site digital connectivity.	There are limited opportunities to intervene in existing developments. There is also currently no scope within the planning system itself to require providers or service operators to share their own digital infrastructure. The focus should therefore be on heightening requirements for new developments. The planning system can help to ensure that sufficient infrastructure and space for additional infrastructure is provided, in order to allow for multiple providers or operators to serve any one development – and thereby to ensure consumer choice and market competition This is addressed in the following rows.
Minimal existing policy requirements for broadband infrastructure	

Building Regulations require all new buildings, and major renovations, to have the necessary in-building (and 'technologically neutral') physical infrastructure to enable connections to superfast broadband. However, neither Building Regulations or the planning system (at a national or local level) currently provide any requirements for new development to facilitate access to the <i>fastest</i> speeds of internet (currently ultrafast) or to provide the flexibility to be able to accommodate future advancements in technology. Although national policy is encouraging of rolling out high speed broadband, the focus has previously been on strategic provision. As such, the proposals set out in this report would be a step change and carry the risk of being seen to place a greater burden by developers unless the benefits are clearly articulated.	The National Planning Policy Framework recognises that 'advanced, high quality communications infrastructure is essential for sustainable economic growth' and supports actions to improve communications infrastructure through the planning system. The GESP policies and local policies should seek to ensure that new sites provide the necessary infrastructure, and that they build in the flexibility to enable consumer choice and market competition between digital services. To do so, the GESP and local authorities should create an environment that: • creates a benefits case to incentivise developments – in written form; • engages proactively with developers and broadband providers to gain 'buy-in'; • requires as many new developments as reasonably possible to make the optimum infrastructure provision through the use of planning policy; • provides helpful guidance to facilitate those designing and applying for new developments with guidance on the physical requirements necessary to facilitate on-site access to the fastest and most up-to-date digital connectivity technologies; • seeks financial contributions, where appropriate, to the improvement of off-site technology, in order to ensure that new sites and (where possible) existing sites with the necessary infrastructure can be connected to, and therefore gain from, the roll out of the most up-to-date technologies.
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Establishing thresholds for a justifiable policy	
There is a need to avoid placing overly onerous requirements on developers – and for planning conditions to comply with the criteria set out in paragraph 206 of the NPPF: ○ necessary; ○ relevant to planning and; ○ to the development to be permitted; ○ enforceable; ○ precise; and ○ reasonable in all other respects. As such, policies requiring the delivery of the infrastructure outlined in the strategy are unlikely to be applicable to all development proposals. This requires clear thresholds to be set to ensure that conditions can be reasonably used to require the policy requirements to developments. This challenge also applies to the ability to enforce policies (see below).	Clear and justifiable thresholds should be identified and consulted on, to ensure policy is reasonable and relates to the scale of the project. This could be done through the following process: • first, prepare a Development Plan Document ('DPD') policy that indicates the need to refer to subsequent guidance (a Supplementary Planning Document) for up-to-date thresholds and technical requirements, as SPDs could be more easily updated; • second, identify the costs and technical requirements required to ensure developments can be connected to by a variety of providers of ultrafast broadband (and repeat this process and update guidance accordingly as technology advances); • third, using this information, identify thresholds above which developments should typically be able to (viably) incorporate up-to-date connectivity infrastructure. This might include largescale and/or major developments, and for new build commercial developments (e.g. offices/creative workspaces) or Build to Rent¹²⁹ – but must be properly tested in the first instance and as time goes on; and • finally, consult with developers, to understand developers' concerns, thus allowing policies and justifications to be better informed and more effective and responsive.

¹²⁹ Build to Rent ('B2R') is identified here because (i) B2R is typically more weighted towards a younger age group who rely more heavily on connectivity for work and social life; and (ii) B2R tenants are typically inherently those seeking

Ensuring compliance with policy through the use of conditions and planning obligations	
Paragraph 204 of the NPPF restricts the use of planning conditions except where they are required to make an otherwise unacceptable development acceptable. Regulation 122 of the Community Infrastructure Levy Regulations 2010 (as amended) and Paragraph 204 of the NPPF further require planning obligations to be <i>'fairly and reasonably related in scale and kind to the proposed development'</i>. A key limit to the use of planning policy to require the incorporation of digital connectivity infrastructure might therefore be for developments on which: - the extent of the works required could be inappropriate or of an unreasonable scale – for example, listed buildings, minor or householder applications, refurbishments, or developments for which no underground works are required; and/or - it may be unviable – for example, smaller or highly constrained residential schemes – subject to viability testing.	In order to secure the delivery of the necessary physical infrastructure, carefully worded and proportionate planning conditions should be used. Because these conditions must comply with paragraph 206 of the NPPF, they are only likely to be applicable to developments above locally determined thresholds, as discussed above. An example of such would be a condition requiring details of the design of on-site ducting and risers to be submitted to the local planning authority for approval prior to commencement of development. This has been done successfully, for example, in North Somerset, and has been proposed in the emerging local plan for South Downs National Park. In order to ensure that such conditions can be found necessary, relevant and reasonable, a firm policy basis should be established to require developments to facilitate the digital infrastructure objectives that are the subject of this section (subsection a) - above), and which explains that planning conditions will be used to ensure new developments comply with this policy. The available policy options are discussed further below in this section. In situations where one or more digital connectivity service providers do not wish to utilise the developer's pre-installed digital infrastructure (duct), but wish to install their own, either at design/build stage or retrofit, this should be encouraged also (ideally at design stage), as it only serves to increase supply options and competition. This should not however be a justification to remove the advice to/ requirement for developers to install their own infrastructure (duct), even if the service provider is willing to let others 'fully share' their network and/or lay their own duct in the duct, in order to avoid potential future network sharing issues; for example, as a result of future changes in management, ownership or approaches by providers or operators.

convenience living and willing to pay a bit more for a premium service. This is based on our experience of a number of the larger / longer operating B2R schemes. However, as this is clearly a new market there is limited evidence on this. It would be sensible to introduce monitoring mechanisms of broadband speeds achieved on new developments in order to support and inform the councils' future planning policies.

Funding and delivering strategic broadband infrastructure requirements (i.e. beyond property boundaries)	
Largescale developments or remote areas may require a significant amount of digital connectivity infrastructure in order to facilitate connections to the on-site ducting and risers. At times the costs of doing so may be disproportionate to the scale of the development, or it may be difficult to attract service providers or operators to such an area. The primary resulting challenge of this is that it is not appropriate to require properties to be fibre-ready if the infrastructure to make this a reality will not reasonably be delivered.	CIL or S106 Agreement contributions may be used to fund wider necessary infrastructure, which might include infrastructure to connect developments so that they are not just 'broadband ready' and are connected up. The primary opportunities include: • incorporating contributions to broadband infrastructure onto the CIL Regulation 123 list where there is a wide-ranging need, to secure funding for this from all developments in areas for which there is a CIL charging zone in place; or* • use of S106 Agreement contributions for the same purpose, where the requirement is likely to be for specific sites or areas. *The use of developer contributions for delivery of such potentially largescale infrastructure has the potential to raise 'double-dipping' or pooling issues. These issues are discussed further below and require careful consideration by each local authority.
Ensuring applicants can understand the practical implications – now and in the future	
Whilst the physical infrastructure recommended in this section is not new, its introduction in to planning policy is relatively new and has the potential to introduce a need for technical information that is not always known at the planning application stage. It will be necessary to ensure that it is not overly onerous for applicants to identify existing infrastructure connectivity (i.e. existing speeds and existing physical infrastructure), and to understand the technical requirements, and practical implications of, meeting the policy objectives. In particular, the resulting considerations include: • how to make it easier for developers to identify this information; and • whether this can reasonably be achieved on minor/smaller scale developments where no works underground are proposed.	Partnering with providers (by local authorities or developers) may provide opportunities to make information on existing speeds and the technical specifications of the necessary infrastructure more widely accessible. To do so, councils should support this process by engaging with broadband providers to produce guidance and develop a clear process through which any developer/applicant can more easily understand the practical implications of the policy for them and how to find the information they need. This digital connectivity strategy goes some way to explain the current technical specifications that would enable developments to be capable of accessing the fastest broadband speeds at the time of writing. However, as time goes on, requirements will change and these wider partnerships and engagement with the industry will become more important.

d) Components of sound and effective policies

- 22.14 Any planning policy must display the following four characteristics in order not only to be found 'sound' by a planning inspector, but also to be effective and welcomed by the council: flexibility, a clear benefits case, an evidence-based justification; and proper consultation.
- 22.15 These aspects are detailed further below.

i. Allowance for flexibility

- 22.16 The most effective policy environment will be flexible and responsive to developments in industry practices. This digital connectivity strategy provides an evidence base for the recommended policy interventions. As time goes on and technology progresses, however, this strategy will become ‘out of date’ and, should the policies not be flexible enough to respond to emerging technology, so will the proposed planning policies. As a result, any such policies could become less justifiable and, therefore, less enforceable.
- 22.17 As an example of how industry developments may affect the reasonableness and effectiveness of broadband-related planning policy, it is understood that BT (Open Reach) may be looking to invest in two forms of consumer broadband technology over the next 5-10 years that will deliver ultra-fast. These comprise:
- G-fast - which uses the remaining final copper connection from the cabinet, is relatively low cost compared with laying new fibre, delivers 300-500 Mbps download or more, but is extremely distance sensitive to the length of copper from the green cabinet. BT's current proposals are to provide G-Fast to 7.5m households.
 - Fibre to the premises – BT's current proposals are to deploy FttP to 2.5m households. Businesses, however, will continue to have to pay for bespoke lease line services.
- 22.18 This is just one example of the way in which the industry might evolve and change. In any such industry development, appropriate attention would need to be given to the implications for planning policy (as and when it is reviewed and updated) and guidance (at any time). For example, subject to a better understanding of where these initiatives could be deployed, such developments could have the potential to make a strict planning policy environment pertaining to broadband less necessary (or more, if the roll-out were not in Exeter), but such developments would not necessarily provide full open access and hence opportunity for consumer choice. A flexible policy might, therefore, allow the specific technical requirements of new development to be set out in guidance that can be easily updated, such as in a Supplementary Planning Document rather than a Development Plan Document.

ii. Demonstrate a clear benefits case

- 22.19 Ideally, planning policy requirements would not be solely relied upon to ensure developments provide the most up-to-date technologies. There are many advantages to defining a benefits case alongside this (i.e. the “carrot” alongside the “stick”).
- 22.20 Any planning policies and planning guidance should emphasise the benefits of doing so and allow for local planning authorities to place *proportionate* requirements on developers to incentivise, but not to unnecessarily burden developments.
- 22.21 It is recommended that this benefits case is developed and conveyed through the following methods.

- **Quantifying and conveying the added value**

Ultrafast broadband could be a significant added value benefit for new developments, particularly new commercial/office developments for the creative or technological sectors or Build to Rent developments.

As such, there is the potential that this provision has low – and no net – cost to the operator. As such, it would be beneficial to bring the benefits of modern digital connectivity standards to the forefront of developers’ mindsets. This might be through the inclusion of such standards in the definition of Build to Rent (i.e. in the same way that many Councils state that Build to Rent must be of a certain scale, include on-site management provision, etc., GESP and GE authorities’ policies could state that it must include high speed broadband infrastructure – or typically does so) or any policy requirements for employment space to serve creative or technological sectors.

In order to better understand the value implications, it would be sensible to begin to engage with developers and to monitor the broadband speeds achieved and/or sought by new tenants of such developments.

- **Council Marketing**

For residential development:

Exeter faces challenges retaining university students as they move in to work. However, retention of this demographic and attraction of those young professionals looking for a well-connected but reasonably priced location to buy a home, could provide significant economic opportunities for the GE area. This client group places great importance on reliability and speed of internet connection. The Council could develop a brand / accreditation such that those developers providing the appropriate infrastructure can market their homes as “high speed” ready etc. and the Council can also support this marketing via its own communications channels.

For office and commercial development:

Reliability and speed of internet connection is of similar, if not greater, importance to attracting and retaining businesses, which increasingly depend on the internet for their daily functions; particularly in high tech industries. This could ensure that Exeter is able to compete for businesses with other locations that have advanced infrastructure, such as Bristol and London.

- **Taking leadership**

Developers are often frustrated by the lack of joined up thinking and strategic planning by telecommunications providers. Measures to ensure that the councils can use their powers and influence to ensure that developers get the best service from utility providers include mapping the development pipeline to make the case for early strategic upgrades and chairing occasional working groups to put pressure on providers where problems are arising.

- **Industry consultation**

In addition, it could be appropriate to establish a developers’ forum in which to hear developers’ perspectives on the issues they face and to present and discuss the benefits noted above. These could be arranged as and when the districts consider appropriate but could first be held prior to publishing draft policies for consultation, in order to allow their feedback to properly feed in to policy development and to allow developers to be aware of the likely policy progression, such that broadband requirements can be factored in to scheme design as early as possible.

- 22.22 Collectively, these measures can help to demonstrate that the authorities have conviction in, and will work positively to achieve, their digital connectivity aspirations.

iii. An evidence-based justification

- 22.23 Planning policies must be reasonable, and evidence based. The evidence presented in this wider strategy provides the wider broadband and digital connectivity context for the recommendations to introduce planning policy requirements relating to broadband for the GE area.
- 22.24 Combined, the evidence presented in this strategy, and the evaluation of the various policy mechanisms discussed above, support the aims of making further policy interventions at district level, and more detailed planning policy guidance, than is applicable at the regional level.
- 22.25 In essence, the reasons relate to economic (GVA) benefits of broadband improvements and to the social and environmental benefits of broadband improvements; enhancing and spreading the GVA benefits as widely as possible, meanwhile potentially reducing the need to travel.

iv. A robust and meaningful consultation process

- 22.26 It will be important for the Councils to consult on emerging broadband policy and guidance, to ensure it is reasonable, addresses its intentions and therefore is likely to be effective, and that it has undergone a legally 'sound' process of development. Additionally, this can help to ensure that policy development is a two-way, responsive process, thereby helping to ensure that the purpose and mutual benefits of such policy or guidance can be understood and therefore been seen as less burdensome.
- 22.27 As this note has alluded to, consultation on development plan and supplementary guidance should be in two forms:
- in the form of formal consultations, conforming with the requirements of relevant planning Acts and Regulations;
 - in the form of small-group developers' forums, held between the councils and developers in order to discuss the industry's needs and challenges in relation to broadband infrastructure, and to convey and discuss the benefits.

e) Planning policy recommendation

- 22.1 The recommendation comprises two parts: an immediate-term recommendation for the GESP, and a longer-term recommendation to be developed by the respective GESP local authorities.

i. GESP policy recommendations

- 22.2 We recommend the use of a single planning policy within the Greater Exeter Strategic Plan that:
- identifies the primary objectives of the policy – i.e. to facilitate access to the fastest broadband speeds, support consumer choice and effective market competition;
 - establishes an expectation that – wherever reasonable – all new developments will incorporate the on-site physical infrastructure necessary to enable achievement of these objectives, and will make financial contributions to the provision of off-site infrastructure; and
 - explains that the local authorities will incorporate digital connectivity policies in planning documents at a local level, which will provide more detailed requirements and guidance.
- 22.3 Following this, the GESP local authorities should provide additional policy, detail and guidance to ensure that applications respond to the GESP policy in a manner that is locally responsive and appropriate.
- 22.4 Subject to consultation with industry professionals, the wording of this policy could be as follows.

Policy [X]: Digital connectivity infrastructure in new developments

To support the economic and social objectives of the GESP, the authorities are seeking to:

- *reduce barriers (practical and financial) to the installation of, and access to, the most advanced digital connectivity technologies that are reasonably possible for providers and users (at present, gigabit-capable services); and*
- *support consumer choice and effective market competition by requiring ducting sufficient to allow more than one provider to service a development.*

Where reasonable and viable, as a minimum, new developments will be expected to provide the appropriate level of on-site infrastructure necessary to enable these objectives, and to make financial contributions to the delivery of necessary off-site infrastructure to contribute to the connectivity levels of the wider area. The precise mechanism through which contributions will be sought (i.e. via

Section 106 Agreement or the Community Infrastructure Levy) will be determined at the local level, dependent on the system in place at the time.

Applicants are encouraged to go beyond the minimum requirements wherever possible.

Digital connectivity of developments should, once available, be in line with relevant supplementary guidance to be produced by the GESP Councils.

22.5 **The term** ‘where reasonable and viable’ has been used in this policy to allow it to be sufficiently flexible to be determined on a case-by-case basis until the local authorities have been able to identify and adopt locally applicable thresholds, following consultation with providers and technicians to properly understand the practical and financial implications. At a minimum, however, it is likely that ducting with capacity for more than one provider could be required of all new build developments with immediate effect.

22.6 The above policy should be supported by the following text.

Supporting paragraph

As soon as possible, the GESP Councils will establish a well-evidenced policy and guidance context that enables the above objectives to be considered in the development management process. Collectively this should be robust, consistent with relevant national policy and legally sound.

Subject to further viability testing, the aspiration for the guidance is to:

- *identify locally-defined thresholds for developments which will be required to comply with on-site infrastructure requirements and/or to contribute to off-site provisions;*
- *require installation of ducting and internal distribution within new developments to ensure that they can be considered to be ‘fibre-ready’ or ‘gigabit-capable’;*
- *be sufficiently flexible to adapt to incentivise and/or require the use of up-to-date emerging technologies and to respond to industry developments;*
- *identify how applicants will be expected to demonstrate compliance and specify where conditions will be likely to be required;*
- *provide guidance with the technical specifications of policy-compliant infrastructure, in guidance that can be updated in response to changing technology;*
- *explain the positive benefits case for the policies, to incentivise of compliance (this can include case studies, where possible, to demonstrate costs and returns); and*
- *set these requirements in the context of the most up-to-date Government policy on service levels and technologies.*

*The role of planning policy in requiring infrastructure pertains to high level components such as ducting, sub-ducting and access chambers, rather than detailed technical components. **At the time of writing, the ‘minimum’ expectation is that ducting with capacity for more than one provider to lay sub ducting and/or fibre optic cable will be provided in all new build developments with immediate effect.** In time, more specific requirements will be identified by the local authorities through local level planning policy and guidance.*

In time, technological advancements may alter or replace this expectation. Local policies and guidance will be relied upon to ensure that a minimum level of infrastructure can be required that is relative to the technology available at the time and enables the objectives identified in Policy [X] to be met.

- 22.7 It is anticipated that the supplementary guidance to the above policies would seek to explain the components of the physical infrastructure necessary to deliver the policy aspirations. At present, the digital connectivity market can be viewed in terms of value change components, which can be divided in to 4 levels.
1. Duct, i.e. plastic tube(s) (typically 100mm diameter), in which telecoms network can be laid, such as fibre optic cable. Sub-duct (i.e. smaller plastic tubes 30-40mm) can also be laid in the main duct in which fibre optic cable is laid, and access chambers are usually provided every 100 meters. The duct is laid at a certain minimum depth in a trench, which is simply backfilled with suitable material, or may be laid in a trench under a footpath or road. Duct may also be laid in a general services/utilities trench, alongside other services.
 2. Fibre optic cable, comprising a number of fibre optic cores (strands). Cables comprise different numbers of cores (always in multiples of 12) and a typical fibre optic cable might comprise 48 or 96 cores. The fibre optic strands are shielded, and an outer casting provides protection. Cable can be pulled or blown down the duct.
 3. Lit fibre, which enables data to be sent and received. Fibre optical cable is called 'dark fibre' until it is 'lit', which takes place with the installation of appropriate electronic transmission and reception equipment at either end. There are a different types of equipment which send and receive data in different ways; one of the most common is the Ethernet protocol.
 4. Provision of different types of data services, often termed 'retail services' such as internet access/ other managed services using ethernet to deliver.
- 22.8 It is anticipated that the supplementary guidance to the above policies would seek to explain the components of the physical infrastructure necessary to deliver the policy aspirations. In recognition that the physical components can change over time, the components described above are not included in the policy above or its supporting text, but could be usefully included in further supplementary guidance (and/or the glossary to the Plan). This would ensure that it could be easily updated in response to changes.
- ii. Local level policy and guidance recommendations*
- 22.9 In the context of the aims, challenges and opportunities, and justifications above, this section considers the types of policy interventions that should be considered to incorporate digital connectivity and broadband in to planning policy and considers their advantages and disadvantages.
- 22.10 There are four main policy vehicles through which the proposals could be formally adopted by each of the GESP district authorities:
- emerging local plans;
 - separate supplementary planning documents;
 - a joint supplementary planning document;
 - Local Development Orders.
- 22.11 As with the primary policy recommendation above, any policies and policy documents should be consistent with the legal requirements and be well-evidenced and justifiable. This will ensure that it is robust and legally sound and, therefore, not challengeable on a technical basis, either during consultation (if required) or at any other time. Note, however, that any policy document or policy should then be reviewed for its content to ensure that it may legally be applied as a development plan or development plan policy.

22.12 In addition, it is of great importance that policies are developed in consultation with interested developers and telecoms service providers, in order to ensure that policies are not considered to be overly prescriptive such that developers will seek to avoid them.

22.13 This section also considers the merits of the different mechanisms to capture developer contributions for off-site infrastructure.

Policy recommendation for on-site infrastructure

22.14 Appendix P provides a further assessment of the four mechanisms listed above against these considerations and a comparison of their requirements, advantages and disadvantages. This is intended to be a guide for the GESP authorities to begin to consider which planning policy mechanisms are appropriate for their local areas.

22.15 The principal considerations when assessing the merits of each option are:

- the weight the policies would have;
- how quickly and easily the policies could be formally adopted; and
- the scope and unity of the policy document (i.e. its extent of focus on the wider GE area's needs, or on particular needs of the individual GESP districts, and their consistency with one another).

22.16 It is our recommendation that policies should be incorporated in to the emerging local plans and supported by supplementary planning documents.

22.17 Broadband policy set out in a DPD – both in the GESP and its constituent district councils DPDs – should carry forward the thrust of the aims above, providing the main expectations and the information that will be required. Where necessary or appropriate, this should refer to existing or future supplementary planning guidance. The policies should also be clear about the councils' intended role in delivering the GESP vision and the economic, social and environmental objectives of the policy. This approach will carry the most 'weight' in planning terms, thereby making the policies the most enforceable, as compared to the use of supplementary planning documents.

22.18 In addition, the local authorities should provide and update guidance on its implementation in a supplementary planning document, to provide as much helpful guidance as possible. At the time of writing, it is recommended that such guidance should include the typical technical specifications of the primary components necessary to support the achievement of the broadband objectives (i.e. the digital connectivity network technologies and the value chain 1 components).

22.19 To secure provision of the necessary infrastructure development, planning conditions can be used (where it is reasonable, proportionate and necessary to make the development acceptable in planning terms). Paragraph 126 of the National Planning Policy Framework (NPPF) states that planning conditions should only be imposed where they are necessary, relevant to planning and the proposed development, enforceable, precise, and reasonable in all other respects.

22.20 However, recognising that the local authorities are at different stages of local plan preparation and that it can be a lengthy process to gather the evidence required to support local plan policies and to go through the local plan examination process, as an interim measure it might be appropriate to first develop supplementary planning documents. Creating an SPD would be very similar to a DPD in form, but it would carry less weight in policy terms because it would not be subject to examination and would remain a material consideration, supplementary to the development plan.

22.21 Additionally, it might be appropriate to incorporate aspects of digital infrastructure connectivity requirements in to Local Development Orders ('LDOs') where they are already being developed for

specific sites areas – for example, in sites coming forward within areas identified as sites for significant employment or housing development.¹³⁰

- 22.22 The benefit to the use of LDOs is that LDOs might provide appropriate mechanisms in which to allow providers or developers to implement broadband-related development in a more strategic and joined-up manner, without the need for – or reliance on – individual planning permissions. Where an LDO has been successfully adopted and incorporates such measures, this could give broadband providers greater confidence that development will come forward in a manner – and thereby incentivise them to develop their networks to/across the LDO area.

Policy recommendation for off-site infrastructure

- 22.23 In addition, there may be circumstances in which it is considered necessary for developments to make contributions to off-site broadband infrastructure. For example, in remote areas which are less attractive to service providers and operators, it might be necessary for such contributions to be used to provide the initial off-site infrastructure costs, thereby making the area more attractive to providers and operators.
- 22.24 These requirements primarily relate to off-site ducts (and the trenches in which they are laid), access chambers and cables, but could also apply to policies that address wider aspects of telecommunications infrastructure, such as a policy encouraging applications for telecommunications masts.
- 22.25 In these circumstances, CIL and S106 agreements are the two main mechanisms through which funding for broadband infrastructure could be captured through the planning regime. It is important that the mechanism is selected carefully, because the CIL regulations prohibit the collection of contributions through both mechanisms for the same infrastructure, (sometimes known as ‘double dipping’) and the regulations also restrict pooling of more than five obligations towards a single project.¹³¹

i. S106 obligations

- 22.26 S106 Agreements would be negotiated on a site by site basis and often contribute towards the off-site provision of facilities that are necessary to enable a development to be considered acceptable. S106 agreements can pool a maximum of five obligations but must be site specific.
- 22.27 Paragraphs 203-205 of the NPPF state that planning obligations should only be used if they are: necessary to make the development acceptable in planning terms directly related to the development fairly and reasonably related in scale and kind to the development.
- 22.28 For broadband policy, it may be reasonable to require S106 contributions to broadband infrastructure in relation to an adopted DPD policy, if it can be proven that this is necessary to make the development acceptable in planning terms. For this reason, the justification for any such policy is extremely important. As an example, a justification for such a requirement of a largescale housing development might be: *‘to provide the future occupiers of the development with a greater opportunity for home*

¹³⁰ Local development orders (LDOs) are used to accelerate delivery through the simplification of planning. From the perspective of a local authority, LDOs signal a shift away from waiting for the market to realise development aspirations for a particular area, and towards initiating development activity by pro-actively granting consent for those aspirations. LDOs effectively grant planning consent for particular types of development in a designated area. Conditions can be imposed on development within the LDO and details to satisfy these conditions must be agreed with the local authority as and when development comes forward – akin to an outline planning permission. Developer contributions can also be specified within an LDO. LDOs do not preclude planning applications being made for development that does not comply with the LDO parameters.

¹³¹ At the time of writing, the Government is consulting on lifting the section 106 pooling restriction (MHCLG, ‘Supporting housing delivery through developer contributions’, March 2018). The progress of this consultation may become an important factor in the selection of the mechanism used to collect funding for broadband infrastructure.

working and a reduction in car-based commuting'. This wording was used by the Inspector of an appeal against refusal of a residential development in Worcestershire, in which provision of broadband was a matter of discussion. In his report, the Inspector wrote:

"To provide the future occupiers of the development with a greater opportunity for home working and a reduction in car-based commuting, I find that a condition on the provision of superfast broadband is necessary".¹³²

ii. CIL contributions

- 22.29 Our research has identified few circumstances in which councils have listed '*broadband infrastructure*' in their CIL Regulation 123 lists, and where it has been included, very little further detail has been provided.
- 22.30 Nevertheless, where broadband infrastructure needs are greatest, CIL could also be used to contribute to broadband infrastructure without being affected by the limit on pooling S106 Agreements. The inclusion of broadband infrastructure on a CIL Regulation 123 list would therefore seem to be most appropriate for areas in which strategic works are required – or where the council may need to carry out works itself, or to fund works by providers. This may be the case where new and existing ducts need to be 'joined up' in more remote areas that are unlikely to attract providers; or where the scale of the cost of doing so could be unreasonably burdensome on the viability of the (potentially small scale) developments.

f) Case studies

- 22.31 Below we consider two circumstances in which broadband has effectively fed in to planning policy. It is important to note that broadband is less widespread in planning policy than many other types of utilities infrastructure (water, energy, etc.) and that this provides fewer firm case studies on which to base policies. It will therefore be important to monitor the effectiveness of any future adopted policies but will also enable the council to develop a well-justified and potentially innovative approach to policy and monitoring of this topic.

i. North Somerset Council

- 22.32 Useful planning policy has been developed that sets out clear broadband requirements and justifications for this (see Policy DM48 in the Development Management Policies DPD adopted July 2016). The policy sets out:
- **thresholds** (proposals for +10 dwellings or employment developments of +200sqm);
 - **practical requirements** ('*applicants should demonstrate how the proposal will be able to accommodate superfast broadband (24Mbps+) and be compatible with local broadband fibre networks where relevant. Where needed, multiple ducts will be provided to enable several providers access to the site*');)
 - **the Council's role** ('*appropriate technology will be identified that will deliver superfast broadband as part of infrastructure planning and should be considered early on as part of a comprehensive utility network plan*');)

¹³² Appeal reference APP/J1860/W/15/3131939.

- **the Council's awareness of viability concerns** (*'costs associated with additional works can be considered as part of any viability assessment'*);
 - **how this will be secured** (*via planning condition*)
 - **policy aims and justifications** (*i.e. broadband infrastructure is critical to attracting employment, to future proofing developments so that that can adapt to future developments, to benefiting SMEs, etc.*);
 - **delivery and monitoring intentions** (*broadband connectivity in new major developments will be monitored and reported on in the Annual Monitoring Report*).
- 22.33 Prior to this, North Somerset Council had included broadband infrastructure in their draft Development Contributions SPD. Objections were raised to its specificity, as it set a requirement for multiple telecoms ducting and wayleave agreements to enable the ducting to be shared by commercial suppliers.
- 22.34 Therefore, based on feedback, it was amended and replaced by a policy within the DM DPD. The policy secures the requirement through planning conditions instead, with the exact details of the connection to be site specific. The practical implication of this seems to be that there is now a planning policy within the adopted development plan, which sets out clear thresholds and intentions, but allows greater flexibility in terms of the detailed provisions made for each development.
- ii. *Mansfield District Council*
- 22.35 The Mansfield District Council Planning Obligations SPD includes a section on 'infrastructure provision and potential planning obligations'. This SPD separates infrastructure into 'infrastructure priorities' and 'potential infrastructure', and within these ranks types of infrastructure these into three categories; Priority 1 ('Critical'), Priority 2 ('Essential') and Priority 3 ('Desirable'). The SPD categorises 'Utilities investment in water, sewerage, gas and electricity networks, Strategic and communication infrastructure including super-fast broadband infrastructure' as Priority 3 potential infrastructure.
- 22.36 This example is interesting because the SPD seeks generally for developments to contribute to Priority 2 infrastructure (affordable housing, highways, education, open space, health and flood risk provisions), but states that:
- 'It may be appropriate for developments to contribute to Priority 1 and 3 infrastructure provisions in the following circumstances:*
- *the scale of the development is such that it will have an impact on the strategic infrastructure listed in the IDP in terms of increased demand; and*
 - *the development proposed is located within close vicinity to and would have a direct impact on / benefit from the strategic infrastructure listed in the IDP; and*
 - *the on-site provision of priority 2 infrastructure is not practicable, and the above criteria are met.'*
- 22.37 This text is helpful in that it offers the decision maker the flexibility to determine when an application is likely to adversely affect existing provision or to *benefit from* such infrastructure. In order to offer developer certainty, however, it might be helpful to set out guidance as to circumstances in which this is likely to be the case.
- g) Conclusions and recommendations**
- 22.38 The GESP can go a long way toward setting out the digital connectivity priorities and objectives of the area. The policies in this document, when adopted, should be capable of carrying significant weight in the determination of future planning application (in balance with other factors, as with all planning documents).

- 22.39 This section has identified the primary challenges and opportunities for the planning system to support the delivery of these objectives to:
- *reduce barriers (practical and financial) to the installation of, and access to, the most advanced digital connectivity technologies that are reasonably possible for providers and users (at present, gigabit-capable services); and*
 - *support consumer choice and effective market competition by requiring ducting sufficient to allow more than one provider to service a development.*
- 22.40 To fulfil these objectives, it is recommended that in the first instance this should be achieved through the introduction of a policy to the GESP that requires that the necessary infrastructure is provided in as many new developments as reasonably possible. This policy should identify an intention to provide further guidance on the implementation of this policy, and an intention to incorporate similar policies in district-level Local Plans and guidance.
- 22.41 In order to encourage compliance, however, the GESP must emphasise the benefits of doing so. This approach is justified by the evidence provided in this Digital Connectivity Strategy. These benefits are explained in the wider strategy.
- 22.42 In addition, to provide a more detailed planning policy that is capable of carrying as much weight, policies pertaining to digital connectivity and broadband could – and should – be incorporated by GESP district councils as emerging Local Plans come forward.
- 22.43 The right policy approach could support (rather than become a barrier to) development and also play a significant role in deploying more broadband more quickly. A correctly drafted DPD policy should be technically robust and consistent with national policy and as such be appropriate to consult on and for timely adoption.
- 22.44 A meanwhile or alternative option would be to develop SPDs relating to digital connectivity and broadband infrastructure – either jointly or separately. It will be for the Councils to determine which is the most suitable option for their authorities and to determine whether there is a ‘trade-off’ in terms of the amount of time it would take to develop this and the extent of detail this would allow them to provide.
- 22.45 LDOs might also be used to supplement such policies in areas in which LDOs are already being used to stimulate development, and the cost and time in their preparation has been determined to be worthwhile. This is somewhat untested territory; however, this does not mean that it should not be trialled in areas in which LDOs are being considered for other reasons.
- 22.46 At this stage, it is not appropriate to make a firm recommendation as to the district-level policy interventions until the merits of each option have been assessed in the context of each local authorities’ local development framework timetables, individual authorities’ constraints, and whether they have a CIL charging regime in place.

23. Appendix A: Glossary of Key Terms¹³³

Glossary of Terms

- ISDN: Integrated Services Digital Network (ISDN) is a telecommunications technology that enables the transmission of digital data over standard phone lines. It can be used for voice calls as well as data transfers.
- ADSL: Asymmetric Digital Subscriber Line (ADSL) is a type of DSL, which is a method of transferring data over copper telephone lines. While symmetrical DSL (SDSL) uploads and downloads data at the same speed, ADSL has different maximum data transfer rates for uploading and downloading data.
- ADSL2+: an extension to ADSL broadband technology that provides subscribers with significantly faster download speeds when compared to traditional ADSL connections.
- VDSL: Very High-Speed Digital Subscriber Line (VDSL) transmits data in the 13 Mbps - 55 Mbps range over short distances, usually between 1000 and 4500 feet (300 - 1500 meters), of twisted pair copper wire. The shorter the distance, the faster the connection rate.
- VDSL2: 2nd generation VDSL runs on a different frequency (30 MHz) to original VDSL over 7 different bands to produce extremely high bandwidth capabilities. It can be accessed through the copper wire phone lines that are already in place. This makes it extremely easy to get a fast connection which is available to businesses and organizations which need a line that could be split over a large network with more than normal strain.
- DOCSIS 3.0: Data Over Cable Service Interface Specification (DOCSIS) is a telecommunications standard used to provide Internet access via a cable modem. DOCSIS 3.0 is simply a more recent version of the standard.
- FTTP: Fibre To The Premises (FTTP) is the installation of optical fibre from the carrier directly into the home or office. It can also be called "fibre to the home" (FTTH). It provides an end-to-end fibre optic connection the full distance from the exchange to the building and can deliver faster speeds than FTTC as there is no copper leg at all.
- FTTC: Fibre To The Cabinet (FTTC) is the installation of optical fibre to a street cabinet in a neighbourhood that serves customers typically within a thousand-foot radius. The technology involves running fibre optic cables from the telephone exchange or distribution point to the street cabinets which then connect to a standard phone line to provide broadband. This is combined with a copper cable from the cabinet to the home or business which uses VDSL or similar technology that can deliver much faster speeds over shorter distances.
- G.fast: high-speed versions of copper based technologies that can reach 1 Gbps on very short copper local loops and speeds up to 150 Mbps on loops not longer than 250 meters
- Local Loop: the communications lines between a customer and the telephone company's central office or distribution station. Often called the "last mile," the physical loop has traditionally been copper-based telephone wire.
- Fixed Broadband: high-speed data transmission to homes and businesses using technologies such as T1, cable, DSL and FiOS. The term excludes mobile market.
- Wi-Fi: a facility allowing computers, smartphones, or other devices to connect to the Internet or communicate with one another wirelessly within a particular area.
- Mobile Broadband: a wireless technology allowing mobile devices such as smartphone or tablet to connect to a broadband internet connection wirelessly through a mobile phone network. Speeds are typically less than high-speed fixed broadband subscriptions, however, 4G LTE cellular service increasingly competes with DSL, low-speed cable and satellite offerings
- 3G: third generation of wireless mobile telecommunications technology which features moderately high speed for Internet access compared to the very sluggish 2G systems.

¹³³ This glossary is not set out alphabetically, but is ordered with reference to similar technologies

- 4G: fourth generation of wireless mobile telecommunications technology which allows wireless Internet access at a much higher speed compared to 3G
- 5G: the fifth generation of cellular service, superseding 4G LTE. Expected in the 2020-2023 timeframe, 5G will increase transmission speed dramatically and embrace prioritization. As wireless data increases exponentially, real-time content such as video calling must be given a higher priority than Web pages.
- Leased Line: a permanent telephone connection between two points set up by a telecommunications common carrier. Typically, leased lines are used by businesses to connect geographically distant offices.
- Telephone exchange: a set of equipment that connects telephone lines during a call.
- Mbps: megabits per second is a measurement of peripheral data transfer or network transmission speed (a megabit is equal to one million bits). It is used to rate serial data transmission such as Ethernet and Wi-Fi.
- MB: megabyte (1,000,000 bytes in decimal notation) is a measurement used to describe disk storage capacity, real and virtual memory, and transmission rates.
- Asymmetrical connection: a connection that does NOT have equal download/upload speeds. For example, 60/3 means 60 Mbps download and 3 Mbps upload speed. Asymmetrical speeds are usually found in traditional internet connections, like ADSL.
- Symmetrical connection: a connection with equal download/upload speeds. An example of this is a 500/500 Mbps fibre internet connection, which means you get 500 Mbps download AND upload speeds.
- Bandwidth: generally referred to the volume of information per unit of time that a transmission medium (like an internet connection) can handle. Bandwidth is typically expressed in bits per second, like 60 Mbps or 60 Mb/s to explain a data transfer rate of 60 million bits (megabits) every second.
- xPON: an optical point-to-multipoint access network. There are no optical repeaters or other active devices in a PON, hence the name "passive." PONs are designed for local loop transmission rather than long distance and serve to bring fibre closer to the customer in order to obtain higher speed.
- GPON: a version of PONs. Most current networks use GPON, or Gigabit PON. The ITU-T standard is G.984. It delivers 2.488 Gbits/s downstream and 1.244 Gbits/s upstream.
- XG-PON: a 2010 computer networking standard for data links, capable of delivering shared Internet access rates up to 10 Gbit/s (gigabits per second) over existing dark fibre. This is the ITU-T's next generation standard following on from G-PON or Gigabit-capable PON.
- RFoG: radio frequency over glass (RFoG) is a deep-fibre network design in which the coax portion of the hybrid fibre coax (HFC) network is replaced by a single-fibre passive optical network (PON).
- GSM – the most common set of global standards for the mobile phone system
- WiMAX - (Worldwide Interoperability for Microwave Access) is a technology standard for long-range wireless networking, for both mobile and fixed connections. ... Its technology is based on the IEEE 802.16 set of wide-area communications standards
- FTTH – Fibre to the home
- Altnets –the group of new, fast growing telecoms service providers in the UK
- MNO – Mobile network operator
- SME – small and medium sized enterprise
- IOT – Internet of things – the interconnection via the Internet of computing devices embedded in everyday objects, enabling them to send and receive data
- Dark Fibre – fibre optic cable that current does not have electronic transmission equipment at either end and through which no signal is currently being sent

- Lit Fibre – fibre optic cable that has active electronic equipment at either end and through which a signal is currently being sent
- Backhaul – a network connection from customer or group of customers ‘back’ to the main network
- PoPs – Point of Presence or inter-connection point on a network
- Not spot – localities that currently have no or only poor access to broadband
- VSO – a type of single transmission technology
- Aggregation Model – combination a group of potential customers to place a single (aggregated) order for a service
- Thin Layer Model – see the appendix for a definition
- Dig One Trust – see the appendix for a definition
- SDSL – a type of signal transmission technology
- Contention – sharing a a broadband signal by a group of customers which results in reduction of the bandwidth available to each individual customer
- NGA – next generation broadband access
- DSL – a type of transmission technology
- DSLAM – an interconnection device within a BT exchange
- MDU – an interconnection device with a BT exchange
- EPON – a fibre connection device
- PON – a fibre connection device
- SOHO - businesses run from a small office or home office
- B2B – business to business connection
- RGU – technology within a BT exchange
- SLA – service level agreement
- PSN – public sector network i.e. local authority connections between sites
- M&E – merger and acquisition
- ERoI – Economic return on investment
- Attribution – part of economic impact assessment methodology, referring to the extent to which the benefit being assessed can be attributed to the project or action
- Deadweight - part of economic impact assessment methodology, referring to the extent to which the benefit being assessed would have happened anyway, without the project or action
- Displacement - part of economic impact assessment methodology, referring to the extent to which the benefit being assessed is the result of taking away the benefit from someone else or another business
- Leakage - part of economic impact assessment methodology, referring to the extent to which the benefit being assessed occurs outside of the impact study area
- Multiplier Effects - part of economic impact assessment methodology, referring to the extent to which the benefit being assessed results in secondary and tertiary benefits
- GVA – gross value added, a standard measure of economic value in a business or economy (taking account of profit and wages, but not supplies)

- NPV – Net Present Value - a financial appraisal function that converts amounts in the future to current values taking account of a 'discount rate'
- DX – Digital Exchange
- LDX – Local Digital Exchange
- RTK – a form of geo-positioning technology
- GNSS - A global navigation satellite system (**GNSS**) is a type of satellite navigation that provides global coverage.
- GPS - The GPS (Global Positioning System) is a "constellation" of approximately 30 well-spaced satellites that orbit the Earth and make it possible for people with ground receivers to pinpoint their geographic location. The location accuracy is anywhere from 100 to 10 meters for most equipment.
- GLONASS - (GLObal NAVigation Satellite System-GLObalnaya NAVigatsionnaya Sputnikovaya Sistema) A satellite-based radio navigation system run by the Russian Ministry of Defense. It uses 21 MEO satellites and three spares.
- Galileo - **Galileo** is Europe's own global navigation satellite system, providing a highly accurate, guaranteed global positioning service under civilian control. Currently providing Initial Services, **Galileo** is interoperable with GPS and Glonass, the US and Russian global satellite navigation systems
- White Space – White Space refers to the unused broadcasting frequencies in the wireless spectrum. Television networks leave gaps between channels for buffering purposes, and this space in the wireless spectrum is similar to what is used for 4G and so it can be used to deliver widespread broadband internet.
- VSat – a broadband satellite receiver dish
- CDS – Cornwall, Devon and Somerset broadband team
- Ofcom – the telecoms regulator
- DCMS – Department for Culture, Media and Sport

24. Appendix B: International policy context

Summary - International policy context

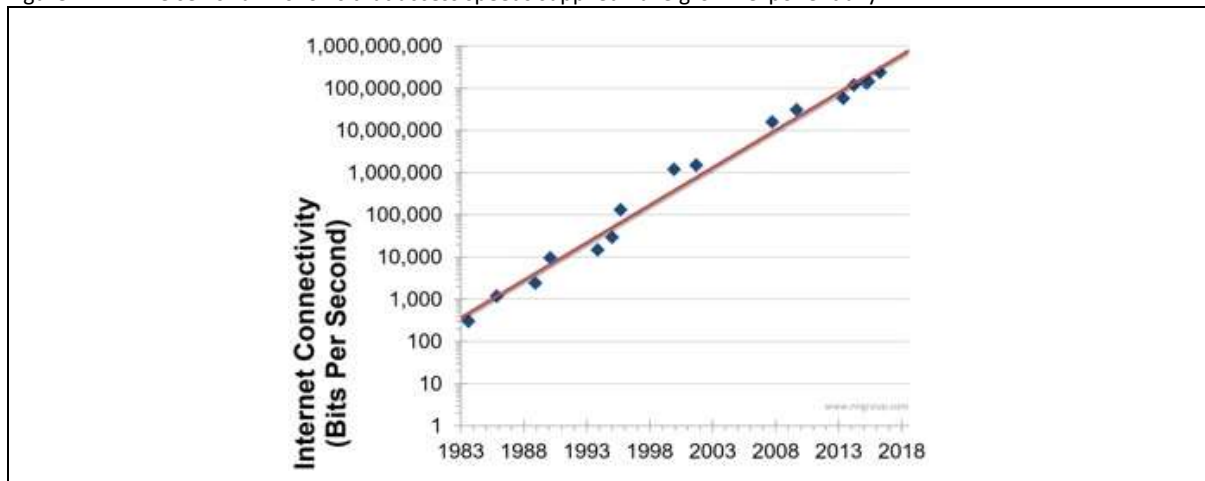
International policy context

- Demand- growing global demand for high speed broadband – 1970s (1-2 Kbps); today (20-50 Mbps) – driven by desire to run existing services faster, rapid escalation of demand video and other data rich content and rise of ‘cloud’ services
- National focus – broadband increasing included as part of telecoms ‘universal service obligation (USO); greater focus on extending the availability of broadband than on measures to stimulate its take-up; broadband speed targets common, but big difference in speed
- Role of Government – big difference:
 - == in Australia, Singapore, Qatar and New Zealand, governments have invested very substantial amounts in the roll out of nationwide NGA networks including wireless, satellite and fibre based technologies.
 - == In South Korea and the US, governments are investing in FTTH¹³⁴ programs in unserved areas, leaving the market to make the remaining investment.
 - == In the UK, France and Ireland, the focus is still on providing first generation broadband in unserved areas.

Growing global demand for high speed broadband

- 24.1 Globally, demand for high-speed broadband has grown exponentially over the past three decades. At the end of the 1970s, 1.2 kbps was considered a high speed for data communications. Today, most domestic users have access to a fixed or mobile broadband network at 20 to 50 Mbps or more. Figure 24.1, below, illustrates this growth in supply.

Figure 24.1: “Nielsen’s Law” shows that access speeds supplied have grown exponentially

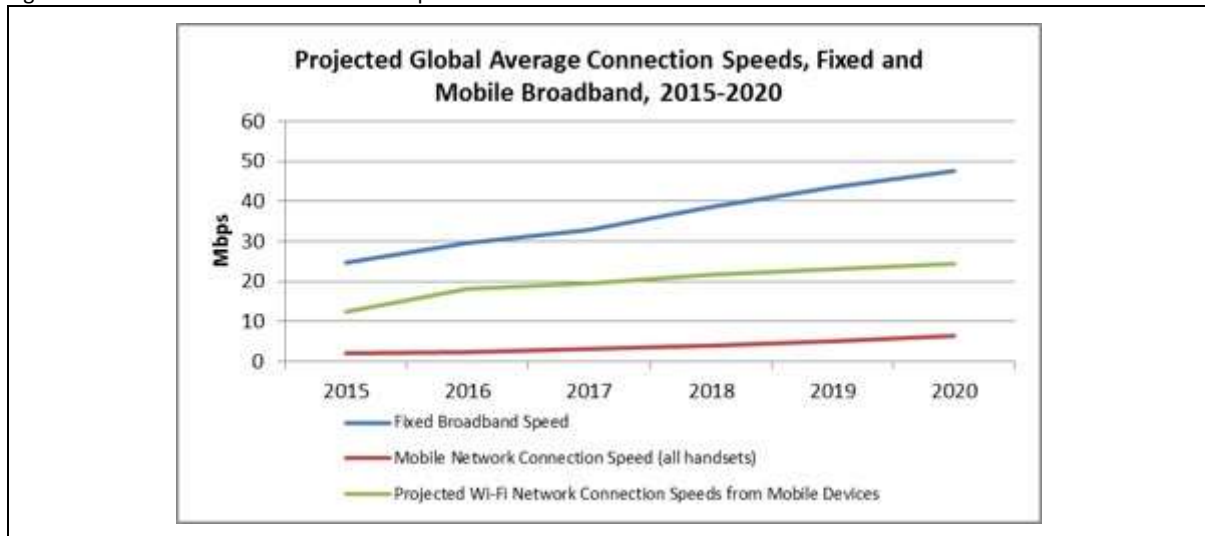


Source: <https://www.nngroup.com/articles/law-of-bandwidth/>

¹³⁴ Fibre to the Home

24.2 Cisco's Visual Networking Index as updated in mid-2016 provides an indication of current and projected near-future growth trends for broadband access speeds across fixed-line and mobile technologies:

Figure 24.2: Trends in Broadband Access Speeds



Data source: Cisco Visual Networking Index, June 2016

24.3 The trend shown in Figure 24.2 of supply of increasingly higher speeds is currently driven by four main factors:

- A desire to run existing Internet applications faster. Higher broadband speeds lead to significant time savings in the use of existing applications, which could be of substantial economic value. Improving broadband speeds to Next Generation Access (NGA), for example might have an impact on GDP. For example, in OECD countries, upgrading from 0.5 Mbps to 4 Mbps increases income by around USD 322 per month, whilst in BIC¹³⁵ countries, upgrading from 0.5 Mbps to 4 Mbps increases income by USD 46 per month¹³⁶.
- Growth in the use of Web 2.0¹³⁷ services such as software-as-a-service, online back-up, and content sharing. To function effectively these applications often require higher reliability, greater consistency of speeds, and higher upload speeds than low quality copper networks can deliver.
- Development of “within premises” wireless networks, which allow multiple users to share a broadband connection, together with growth in the number and variety of devices that can access the Internet.
- Growth in streamed video applications which require low error rates to avoid break-up of the stream, alongside a requirement for symmetric speed to support two-way applications such as video calling and collaboration.

Comparing different countries' approaches to broadband policy

Universal service policy migrating from narrow band to broadband

¹³⁵ Emerging market countries

¹³⁶ Cisco Visual Networking Index, June 2016

¹³⁷ **Web 2.0** is the term used to describe a variety of web sites and applications that allow anyone to create and share online information or material they have created. A key element of the **technology** is that it allows people to create, share, collaborate & communicate.

- 24.4 Countries are now focusing on universal service policy for broadband rather than for narrowband. Most countries already have some kind of supply-side universal policy for the latter.

Focus on extending availability

- 24.5 There is more of a focus on extending the availability of broadband than on measures to stimulate its take-up in many countries. Singapore, South Korea and the UK are exceptions.

Target rollout speeds

- 24.6 There are big differences in rollout targets, as illustrated in Figure 24.3 below.

Figure 24.3: Universal Broadband Targets			
Country	Downstream Access Network Speed per User (Mbps)	Target Year	% of population benefitting
Australia	30	2020	100%
Belgium	100	2020	50%
Canada	50	2021	90%
China	50 (urban)	2020	98%
	12 (rural)		
European Union	100	2025	100%
Finland	10	2021	100%
	2	2015	100%
France	100	2022	100%
Germany	50	2018	75%
Ireland	30	2020	100%
New Zealand	50	2025	99%
Singapore	100	2012	90%
South Africa	8	2020	90%
South Korea	50	2010	100%
Sweden	100	2020	95%
UK	24	2017	95%

There are also big differences in the role of government:

- In Australia, Singapore, Qatar and New Zealand, governments have invested very substantial amounts in the roll out of nationwide NGA networks including wireless, satellite and fibre based technologies.

- In South Korea and the US, governments are investing in FTTH ¹³⁸ programs in unserved areas, leaving the market to make the remaining investment.
- In the UK, France and Ireland, the focus is still on providing first generation broadband in unserved areas.

Demand stimulation measures remain popular

24.7 Figure 24.4 lists types of demand stimulation programmes found in many countries. The UK has pursued some of these, particularly during the RDA¹³⁹ era. Of recent, demand stimulation in the UK has been linked in with/ tied to coverage extension programmes

Figure 24.4: Demand stimulation – types of measure	
Category	Measure
Measures aimed at disadvantaged groups.	ICT literacy programs for : - unemployed people; - older people e.g. to promote independent living; - disabled people; Free or subsidised Personal Computer (PC) and Internet subscriptions to low income groups.
Programs aimed at schools and use in universities.	ICT literacy programs for teachers; ICT literacy programs for pupils; Free or subsidised PC and Internet subscriptions.
General measures to stimulate demand.	Tax breaks for purchase of PCs; Deployment of broadband Internet access points in public buildings such as hospitals, libraries and government offices; Grants to stimulate community deployment of next-generation access broadband; Grants to set up privately run Internet cafes; Aggregation of broadband demand when public bodies procure telecoms services.
Measures to make the Internet more attractive to content providers and safe for end users.	Measures to prevent illegal copying and file sharing; Measures to protect end user privacy and identity security; Measures to remove barriers to secure e-payments while preserving security; Measures to remove any unnecessary restrictions on access to Internet applications and content; Measures to protect children using the Internet from harmful content; Measures to implement e-government services in health, transport, education and public administration; Measures to promote the development of local content.
Measures to increase the relevance of the Internet to citizens.	Funds for training local companies in the development of websites; Subsidy of local companies wishing to develop local content; Social marketing campaigns to make citizens more aware of the value of the Internet;

¹³⁸ Fibre to the Home

¹³⁹ Regional Development Agency

	Development of e-government services e.g. car registration, tax returns; Opening up government data to enable third parties to develop on-line applications; Ensuring that e-government services work well on mobile devices.
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25. Appendix C: National Policy Context

Summary - National policy context

National policy context

- Last 15 years – focus on gap funding incumbent to extent fibre deeper into the legacy copper telephone network to increased broadband speeds; initially ‘fibre to the exchange’ (also termed exchange enablement) programmes, followed by ‘fibre to the cabinet’ (also cabinet enablement) programmes
- Over this period, very limited focus on investment in full fibre network (also termed fibre to the premises (FTTH) or fibre to the home (FTTH))
- Sudden U-turn in policy Aug/Sept 17 with new DCMS minister (now Secretary of State), Matt Hancock announcing shift to encouraging investment in local full fibre networks (FTTP/FTTH)
- Following the failure of the Mobile Infrastructure Programme (2012-17) to address gaps in 2G, 3G and 4G coverage¹⁴⁰, Government has shifted its policy focus to regulation, seeking to require more ambitious coverage requirements from the mobile operators as part of their spectrum licence conditions. The delivery mechanism for mobile within LFFN focused on creating infrastructure for future 5G networks

National digital connectivity policy context

- 25.1 Matt Hancock MP, now Secretary of State at DCMS, has marked a shift in UK broadband policy, stating an ambition for Britain to be ‘world leaders in digital connectivity’ over fibre and 5G networks¹⁴¹ and setting in train a consultation on the benefits of providing both households and businesses with ‘full fibre’ connectivity – fibre to the premises, or FTTP.¹⁴²
- 25.2 This is an evolution of the model of pursuing rollout of fibre to the cabinet (FTTC) hybrid networks, where the final connection to the premise is provided by copper (either a ‘twisted pair’ or coaxial cable), which was designed to maximise penetration within a short time frame and minimise cost to the public purse of intervention, to one in which fibre optic cable is used to provide the final connection to the premises (‘GPON’ - see glossary.)
- 25.3 The shift in policy is also reflected in regulatory review. Ofcom’s current Wholesale Open Access Market Review¹⁴³ has as its goal to, “encourage the large-scale deployment of new ultrafast broadband networks, including fibre,”
- 25.4 Only a small part of this investment will be provided directly by Government, as a stimulus to much larger investment expected from the private sector. Much closer cooperation between Government, local authorities and suppliers will be needed to achieve those objectives. The introduction to the Ofcom Review (above) states that,
- “Investment in new competing networks can bring important benefits to consumers. Network competition is a powerful driver of innovation, leading to higher quality and lower prices.”
- 25.5 The three main elements of this strategy are:

¹⁴⁰ DCMS (2017). Mobile Infrastructure Project Impact and Benefits Report,

<https://www.gov.uk/government/publications/mobile-infrastructure-project-impact-and-benefits-report>

¹⁴¹ DCMS (2016). Minister of State for Digital and Culture addresses the Broadband World Forum. London, 19 October 2016
<https://www.gov.uk/government/speeches/broadband-world-forum>

¹⁴² DCMS (2016). Extending full fibre networks: Call for evidence. London, December 2016

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/580726/Extending_Local_Full_Fibre_Networks_Call_for_Evidence_For_Publication.pdf

¹⁴³ <https://www.ofcom.org.uk/consultations-and-statements/category-1/wholesale-local-access-market-review>

- encouraging and enabling network investment by reducing the cost and barriers to new investment. A key element of this is making it quicker and easier for rival providers to build their own fibre networks using BT's poles and underground ducts that carry telecoms cables. Our proposals include considering how to streamline operational processes and relax restrictions concerning the use of BT's infrastructure, to increase the opportunity for duct and pole sharing;^[SEP]
- regulating access to superfast and ultrafast services to give both BT and its competitors incentives to invest in new networks while balancing the need to protect competition and ultimately consumers. In particular, given the potential for significant consumer benefits, we want to incentivise operators to build new networks rather than rely on buying access from BT; and^[SEP]
- continuing to regulate access to BT's Openreach network and services where network competition is not effective, including in more remote and rural areas."

Extracts from Ofcom's current Wholesale Open Access Market Review

Focus on large-scale deployment of new ultrafast broadband networks, including fibre

One of the key proposals in our Strategic Review of Digital Communications ("Strategic Review") is to make a strategic shift to encourage the large-scale deployment of new ultrafast broadband networks, including fibre direct to homes and businesses (sometimes called 'full-fibre'), as an alternative to the predominantly copper-based technologies planned by BT.¹ Full-fibre networks support very high speeds, ranging from several hundred Mbit/s to 1 Gbit/s or more, and should be more reliable.

- Investment in new competing networks can bring important benefits to consumers. Network competition is a powerful driver of innovation, leading to higher quality and lower prices.
- Our long-term strategy for promoting investment and competition in fixed networks therefore focuses on three main elements:
 - encouraging and enabling network investment by reducing the cost and barriers to new investment. A key element of this is making it quicker and easier for rival providers to build their own fibre networks using BT's poles and underground ducts that carry telecoms cables. Our proposals include considering how to streamline operational processes and relax restrictions concerning the use of BT's infrastructure, to increase the opportunity for duct and pole sharing;
 - regulating access to superfast and ultrafast services to give both BT and its competitors incentives to invest in new networks while balancing the need to protect competition and ultimately consumers. In particular, given the potential for significant consumer benefits, we want to incentivise operators to build new networks rather than rely on buying access from BT; and
 - continuing to regulate access to BT's Openreach network and services where network competition is not effective, including in more remote and rural areas.

Market Analysis

BT and Virgin Media are the largest fixed access network providers, reaching nearly 100% and around 45% of UK homes respectively.¹⁴⁴ Virgin Media's planned network expansion is expected to extend its coverage to 60-65% by 2020. Virgin Media uses its own network to serve its customers. BT, through Openreach, provides wholesale access to other companies, the largest of which are BT Consumer, Sky and TalkTalk who then offer services to customers. Broadband has become an increasingly important service with take-up now at 78% of UK premises.¹⁴⁵ Download speed is prominent in the marketing of these broadband services and in our analysis, we make a distinction between services with download speeds as follows:

¹⁴⁴ Ofcom, December 2016. Connected Nations Report. Fig 37.

https://www.ofcom.org.uk/_data/assets/pdf_file/0035/95876/CN-Report-2016.pdf.

¹⁴⁵ Ofcom, December 2016. Connected Nations Report. Page 1.

- **standard broadband:** download speeds of up to 30 Mbit/s;
- **superfast broadband:** download speeds from 30 Mbit/s up to 300 Mbit/s; and
- **ultrafast broadband:** download speeds of 300 Mbit/s and above. Superfast broadband take-up is growing rapidly, and where it is available 47% of broadband lines were at superfast speeds by mid-2016.

There is no standard definition of ultrafast. The UK Government currently defines ultrafast as 100 Mbit/s or greater. We also consider that the reliability with which the speed is delivered is an important attribute and expect the definition to ultrafast to evolve to take account of the importance of this reliability. We currently take ultrafast broadband services to be those that offer a minimum download speed of 300 Mbit/s or more (a factor of ten greater than that offered by superfast). These services also offer higher upload speeds than superfast broadband. Over time we expect ultrafast technologies to evolve towards providing gigabit speeds and above – 1 Gbit/s or more.

Superfast broadband take-up is growing rapidly, and where it is available 47% of broadband lines were at superfast speeds by mid-2016. We forecast that superfast will account for around three-quarters of all broadband lines by 2020/21.

Different technologies underpin the differences in headline speeds. Superfast speeds are usually delivered via BT's fibre to the cabinet (FTTC) network or Virgin Media's cable network, while standard broadband speeds are normally delivered by copper lines (i.e. with no fibre between the customer and the telephone exchange). Ultrafast services are typically provided using full-fibre networks.

Very limited ultrafast in the UK – 2%

We have very limited availability of ultrafast broadband services, including those based on full-fibre (estimated to be available at 2% of UK premises in 2016).¹⁴⁶ other large European countries have the following availability: Germany 7%, France 16%, Italy 20% and Spain 53%.

Growing consumer demand for faster services is fueling some interest in fibre investment from BT and its competitors, but we believe there is a risk that consumers' interests may be harmed if investment is impeded.

Examples of ultrafast investments and those announced to date include:

- by 2020, BT is planning to deploy full-fibre networks to up to 2m premises and an enhanced form of FTTC network known as G. Fast to 10m premises;⁷
- Virgin Media intends to extend its network to reach a further 4m premises, half of which are to be connected using full-fibre;
- TalkTalk / CityFibre are to extend their full-fibre trial in York from 14,000 homes to cover 40,000 further premises over the next 18 months;
- KCOM in Hull is currently upgrading its network to pass 150,000 premises with full-fibre; and
- a number of smaller providers are also deploying full-fibre; for example, Hyperoptic, whose network reaches 100,000 UK premises, Gigaclear, and B4RN which provide full-fibre in more rural areas.

BT has a high and suitable market share (around 80%) in the WLA market, although this is likely to decline to around 75% by 2020/21, largely due to competition from Virgin Media.⁸ We propose to designate BT as having SMP in the UK excluding the Hull Area. We will address SMP in the Hull Area in a separate consultation document to be published in Q1 2017/18.

Ofcom's proposed strategy

¹⁴⁶ Ofcom, December 2016. Connected Nations Report, paragraph 4.15
https://www.ofcom.org.uk/__data/assets/pdf_file/0036/95895/CN16-04.pdf

Standard broadband

- Our key objective for standard broadband is to have a suitable regulatory regime over the short to medium term during the transition to greater network competition. Our proposals support competition for standard broadband customers which: protects them from the risk of higher prices, avoids stifling demand for higher bandwidth services and improves the quality of services they experience. This is important as today the majority of customers (approximately two thirds) using services delivered via the Openreach network buy standard broadband, and by 2020/21 we forecast that there will still be a significant number of such customers (approximately one third).

Superfast broadband

- Our objective is to strike an appropriate balance between encouraging network investment and protecting consumers and competition in the short term (given that investment in new fibre networks will take time).
- While we also want to ensure that BT continues to have a positive incentive to invest in new infrastructure, we believe that BT has had a fair opportunity to make a return on its original risky investment and that a charge control on the 40/10 VULA service would be consistent with the 'fair bet'. We believe therefore this is no longer relevant to our price regulation of superfast broadband (in contrast to ultrafast broadband).
- At the same time, we want to provide strong incentives for telecoms providers to invest in new ultrafast networks.
- However, we believe the availability of standard broadband services is unlikely to sufficiently constrain BT's superfast broadband prices over the period of this market review. Therefore, there is a significant risk that retail competition would be weaker, and consumers would face considerably higher prices if there was no control on VULA pricing.
- In broad terms the choice is between continuing the existing approach of pricing flexibility, which allows BT to set wholesale prices, subject to the need to ensure that its competitors have sufficient margin to compete at the retail level and setting a cost-based price which our current analysis indicates would be below today's wholesale prices. In the latter case, we would expect that much of the reduction in wholesale prices would be passed through to consumers in the form of lower retail prices.
- We believe the right balance is to control prices of the 40/10 version of VULA but allow BT to continue to have pricing flexibility on VULA services of higher (and lower) bandwidths. This is a natural evolution of our existing approach of combining charge controls and pricing flexibility that supported previous investment cycles.

Ultrafast broadband services

- Our approach in this area is critical to our objective of promoting infrastructure-based competition.
- Given that it will not be feasible to build competitive ultrafast networks throughout the whole UK, BT will have to continue to provide wholesale access to its new network services, including ultrafast services.
- However, we propose that BT should continue to have flexibility in setting the wholesale prices of these services, subject to maintaining a sufficient retail margin for its competitors to compete. This is essentially the approach we adopted for superfast broadband in 2010 and has been a contributing factor to its success to date.
- We believe this 'pricing flexibility' approach will both recognise the risk of BT's investments and encourage competitors to invest in their own networks, rather than relying on buying wholesale services from BT

Quality of service

- Wholesale regulation of local access can also support our goal of achieving a step change in quality of service. A good quality of service at the wholesale level is necessary for both effective competition and a good quality of service for consumers.
- We believe that because BT has SMP in the wholesale market it does not have sufficient incentive to set the quality of service at an appropriate level, or to innovate to improve service quality.

- In 2014 we imposed new quality of service rules on BT in relation to the provision of copper access lines and fault repairs on those lines in order to stabilise BT's quality of service which had steeply declined in prior years.¹⁴⁷ As broadband becomes increasingly regarded as a necessity for consumers, we believe that an increase in quality standards in this area is both proportionate and necessary, particularly as low service quality has a direct and detrimental impact on competition.
- We propose to include a direction making power in the SMP conditions enabling us to set appropriate quality of service standards on BT. A consultation on the detail of our proposed quality of service remedies is being published alongside this document.

Duct and pole access

- A key element of our strategy to promote infrastructure-based competition is to reduce the cost and barriers to new investment.
- In December 2016 we published initial proposals to develop an effective remedy for access to BT's ducts and telegraph poles.¹⁶ The high costs of deploying physical infrastructure, such as ducts and poles, remains a barrier to large scale network deployment in significant parts of the country. These costs constitute a large proportion of the overall capital expenditure of an access network. We therefore want to improve access to BT's ducts and poles to make it easier and more cost effective for telecoms providers to invest in advanced, competing infrastructure so that they can deploy their own fibre optic cables directly to homes and businesses more quickly and at lower up-front cost.
- These proposals aim to address concerns from BT's competitors about the absolute costs and time required to build ultrafast broadband networks at scale. We will publish a further consultation shortly on our proposed duct and pole access remedies.

Source: Ofcom's wholesale local open access market review consultation¹⁴⁸

¹⁴⁷ Ofcom, June 2014. Fixed Access Market Review Statement. <https://www.ofcom.org.uk/phones-telecoms-and-internet/information-for-industry/telecoms-competition-regulation/narrowband-broadband-fixed/fixed-access-market-reviews-2014/statement>

¹⁴⁸ ¹⁴⁸ <https://www.ofcom.org.uk/consultations-and-statements/category-1/wholesale-local-access-market-review>

26. Appendix D: BT exchanges and services in GE

26.1 This appendix lists all the BT exchanges in the GE area, indicating the range of services each can support and the extent of services from other suppliers enabled by local loop unbundling¹⁴⁹

Exchange	Code	Postcode	Broadband Providers
Anstey Mills	(WWANST)	EX169JN	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Axminster	(WWAXMI)	EX135AB	BT Wholesale: ADSL Max (up to 8M) LLU Services: CPW, Sky Cable services: None
Bampton	(WWBAMP)	EX169NT	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Bickleigh	(WWBCKL)	EX168RJ	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Bovey Tracey	(WWBTRA)	TQ139AL	BT Wholesale: ADSL Max (up to 8M) LLU Services: CPW, Sky Cable services: None
Branscombe	(WWBRAN)	EX123DE	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Broadhembury	(WWBROA)	EX143NG	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Budleigh Salterton	(WWBUDL)	EX96RH	BT Wholesale: ADSL Max (up to 8M) LLU Services: CPW, Sky Cable services: None
Cheriton Bishop	(WWCBIS)	EX66JL	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None

¹⁴⁹ Local loop unbundling (LLU or LLUB) is the regulatory process of allowing multiple telecommunications operators to use connections from the telephone exchange to the customer's premises

Exchange	Code	Postcode	Broadband Providers
Cheriton Fitzpaine	(WWCFIT)	EX174HU	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Christow	(WWCHRI)	EX67PL	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Chudleigh	(WWCHUD)	TQ130JG	BT Wholesale: ADSL Max (up to 8M) LLU Services: CPW, Orange, Sky Cable services: None
Clayhanger	(WWCLAY)	EX167NY	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Colaton Raleigh	(WWCRAL)	EX100LE	BT Wholesale: ADSL Max (up to 8M) LLU Services: CPW, Sky Cable services: None
Copplestone	(WWCOPP)	EX175NE	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Craddock	(WWCRAD)	EX153DN	BT Wholesale: ADSL Max (up to 8M) LLU Services: CPW, Sky Cable services: None
Crediton	(WWCRED)	EX172BP	BT Wholesale: ADSL Max (up to 8M) LLU Services: Tiscali, CPW, Orange, Sky Cable services: None
Cullompton	(WWCULL)	EX151JS	BT Wholesale: ADSL Max (up to 8M) LLU Services: CPW, Orange, Sky Cable services: None
Dawlish	(WWDAWL)	EX79DZ	BT Wholesale: ADSL Max (up to 8M) LLU Services: AOL, Tiscali, CPW, Orange, Sky Cable services: None
Drewsteignton	(WWDREW)	EX66RB	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None

Exchange	Code	Postcode	Broadband Providers
Exeter	WWEXTR	EX43PT	BT Wholesale: SDSL, ADSL Max (up to 8M) LLU Services: Bulldog, AOL, Tiscali, CPW, Be, Orange, Sky Cable services: Virgin
Exminster	WWEXMN	EX68AB	BT Wholesale: SDSL, ADSL Max (up to 8M) LLU Services: undefined Cable services: Virgin
Exmouth	WWEXMO	EX82RZ	BT Wholesale: SDSL, ADSL Max (up to 8M) LLU Services: AOL, Tiscali, CPW, Be, Orange, Sky Cable services: None
Farway	WWFARW	EX246DH	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Feniton	WWFENI	EX143BB	BT Wholesale: ADSL Max (up to 8M) LLU Services: CPW Cable services: None
Hawkchurch	WWHAWK	EX135XA	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Hele	WWHELE	EX54PR	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Hemyock	WWHEMY	EX153PD	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Honiton	WWHONI	EX141ET	BT Wholesale: ADSL Max (up to 8M) LLU Services: CPW, Orange, Sky Cable services: None
Ipplepen	WWIPPL	TQ125RT	BT Wholesale: ADSL Max (up to 8M) LLU Services: CPW, Sky Cable services: None
Kennford	WWKENN	EX67TH	BT Wholesale: ADSL Max (up to 8M) LLU Services: CPW Cable services: None

Exchange	Code	Postcode	Broadband Providers
Kentisbeare	(WWKENT)	EX152BR	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Kingskerswell	(WWKKWL)	TQ125BD	BT Wholesale: ADSL Max (up to 8M) LLU Services: CPW, Orange, Sky Cable services: Virgin
Lapford	(WWLAPF)	EX176QT	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Longdown	(WWLDOW)	EX67SN	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Luppitt	(WWLUPP)	EX144QH	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Morchard Bishop	(WWMBSH)	EX176NT	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Newton Abbot	(WWNABB)	TQ122DJ	BT Wholesale: ADSL Max (up to 8M) LLU Services: Bulldog, AOL, Tiscali, CPW, Be, Orange, Sky Cable services: Virgin
Newton St Cyres	(WWNCYR)	EX55DB	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Oakford	(WWOAKF)	EX169JD	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Ottery St Mary	(WWOSMY)	EX111AY	BT Wholesale: ADSL Max (up to 8M) LLU Services: Tiscali, CPW, Orange, Sky Cable services: None
Pinhoe	(WWPINH)	EX49EY	BT Wholesale: ADSL Max (up to 8M) LLU Services: CPW, Orange, Sky Cable services: Virgin

Exchange	Code	Postcode	Broadband Providers
Plymtree	(WWPTRE)	EX152JS	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Rackenford	(WWRACK)	EX168DR	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Sampford Peverell	(WWSAMP)	EX167EF	BT Wholesale: ADSL Max (up to 8M) LLU Services: CPW, Sky Cable services: None
Seaton	(WWSEAT)	EX122JZ	BT Wholesale: ADSL Max (up to 8M) LLU Services: CPW, Sky Cable services: None
Shaldon	(WWSHAL)	TQ140AR	BT Wholesale: ADSL Max (up to 8M) LLU Services: CPW, Sky Cable services: None
Sidbury	(WWSIDB)	EX100RQ	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Sidmouth	(WWSIDM)	EX108TW	BT Wholesale: ADSL Max (up to 8M) LLU Services: Tiscali, CPW, Orange, Sky Cable services: None
Silverton	(WWSILV)	EX55LZ	BT Wholesale: ADSL Max (up to 8M) LLU Services: CPW Cable services: None
Sowton	(WWSOWT)	EX27NG	BT Wholesale: SDSL, ADSL Max (up to 8M) LLU Services: Bulldog, Sky Cable services: Virgin
Starcross	(WWSTAR)	EX68QS	BT Wholesale: ADSL Max (up to 8M) LLU Services: CPW, Sky Cable services: None
Stockland	(WWSTOC)	EX149EY	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None

Exchange	Code	Postcode	Broadband Providers
Stoke Canon	(WWSCAN)	EX54AX	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Tedburn St Mary	(WWTEDB)	EX66AD	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Teignmouth	(WWTEIG)	TQ148EZ	BT Wholesale: ADSL Max (up to 8M) LLU Services: CPW, Be, Orange, Sky Cable services: None
Tiverton	(WWTIVE)	EX166PU	BT Wholesale: ADSL Max (up to 8M) LLU Services: Tiscali, CPW, Be, Orange, Sky Cable services: None
Topsham	(WWTOPS)	EX30DS	BT Wholesale: ADSL Max (up to 8M) LLU Services: CPW, Orange, Sky Cable services: Virgin
Upottery	(WWUPOT)	EX149NQ	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Whimble	(WWWWHIM)	EX52PU	BT Wholesale: ADSL Max (up to 8M) LLU Services: CPW Cable services: None
Wilmington	(WWWILM)	EX149JY	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Witheridge	(WWWWITH)	EX168AN	BT Wholesale: ADSL Max (up to 8M) LLU Services: undefined Cable services: None
Woodbury	(WWWWOOD)	EX51PS	BT Wholesale: ADSL Max (up to 8M) LLU Services: CPW, Sky Cable services: None

28. Appendix E: National Infrastructure Commission (NIC)

- 28.1 This appendix sets out details of key speech by Lord Adonis, indicating the importance the NIC attaches to digital infrastructure

Adonis: tackle the three Cs and deliver world-class infrastructure

National Infrastructure Commission 13/10/17

The UK faces gridlock on the roads, railways and in the skies, **slower mobile and broadband connections** and ever-worsening air quality unless the Government tackles the ‘three Cs’ – Congestion, Capacity and Carbon – Lord Adonis warned today.

The chairman of the National Infrastructure Commission argued that the current state of the country’s infrastructure could hold the UK back – and that a long-term plan is needed to ensure that it is fit for the future.

He especially pressed the need to address “perhaps the most serious infrastructure failure of all” and reach a firm decision on expanding Heathrow Airport – an issue yet to be resolved 13 years after the initial statement of policy for a third runway.

He also warned that the UK risks falling behind other countries in its next generation mobile and broadband connections unless urgent action is taken to increase capacity now and for the future.

- The UK lags behind countries including the USA, the Netherlands and Japan for 4G and broadband speeds

Capacity – as well as **ensuring everyone has access to the latest digital communications technology**, building new infrastructure to support new homes and having sufficient water supply and flood protection to manage extremes of weather; and

Chairman of the National Infrastructure Commission Lord Adonis said:

“We have a proud history in this country of delivering world-class infrastructure – but for years funding has been squeezed, policy decisions have been erratic, and the network is showing signs of age and strain.

“But we also risk falling behind internationally if we don’t improve our mobile and broadband connections, and residents of our great cities will suffer unless we do something to improve air quality.

“We cannot afford to sit on our hands – Ministers must act now to tackle the Three Cs of congestion, capacity and carbon if we are to have infrastructure fit for the future, supporting economic growth across the country.

Mayoral support

Speaking in Birmingham, the chairman of the National Infrastructure Commission was joined by five of the country’s seven Mayors – from the West Midlands, Greater Manchester, London, Cambridge and Peterborough and the West of England.

West of England Mayor, Tim Bowles, said:

“Devolution is giving us an opportunity to tackle key infrastructure challenges at regional level which is why I welcome today’s interim National Infrastructure Assessment.

“For our part we’re working to get the West of England region moving, and to make it easier for people to move around. We’re investing in key routes and looking at how we can get people out of their cars and using alternative modes of transport. I’m also working with Network Rail through MetroWest to improve our regional rail network – including more frequent services, more capacity and new stations for commuters.

“Our regional businesses and universities are at the forefront of innovation and we’re investing in new technology, such as driverless cars. With house prices at up to 10.5 times average earnings in parts of our region, our need to for new homes is acute. We are the first region to develop a Joint Spatial Plan, which will enable a step change in pace of housing delivery. I am looking to Government for support including through the Housing Infrastructure Fund and we’re developing some exciting opportunities in modular house building.

“We also need to get our digital infrastructure right. By connecting people digitally, we can reduce the requirement for journeys, with all the environmental benefits that brings. We are already a beacon for innovation in the area of clean, affordable energy and we are developing an Energy Strategy for the region that will build on this.”

29. Appendix F: BT FttP consultation

- 29.1 This appendix sets out key sections from BT's key consultation which includes comments on possible large-scale fibre to the premises deployment. The Government is pushing BT to deploy more FttP. In contrast, some think that BT would prefer to push G-Fast¹⁵⁰ investment instead. The issue is what balance will be struck between the two technologies.

UPDATE2 Openreach Says "large-scale" UK FTTP Roll-out to Cost up to £6bn

Monday, August 7th, 2017 (11:03 am) - Score 3,306¹⁵¹

- Last month Openreach (BT) launched a new consultation that hinted at a large-scale deployment of "full fibre" FTTPultrafast broadband, which could cover up to 10 million premises by around 2025 (here). Today a leaked copy of that document has pegged the cost at between £3bn to £6bn.
- At present Openreach's roll-out of 1Gbps capable Fibre-to-the-Premises (FTTP) technology is only expected to reach 2 million premises (mostly new build homes and businesses) by 2020, while their 'up to' 330Mbps hybrid-fibre G. Fast solution will do 10 million premises by the same date. Meanwhile the Government have long been pressing them to invest in much more "full fibre" and the growth of rival FTTP/H providers, as well as Virgin Media's network expansion, has also provided some food for thought.
- However, Openreach has said that such a deployment would only work if they had support from major ISPs (e.g. TalkTalk, Sky Broadband) via greater collaboration or cost sharing models, as well as the backing of Ofcom and the Government. For example, they're seeking protection for their investment against aggressive regulation / charge controls and a reduction in logistical barriers (e.g. simpler planning and traffic management processes between local authorities).
- On the flip side ISPs will want to ensure that they have some flexibility to differentiate their products and can offer it at an affordable price. At present it's difficult to perceive of any ISPs committing direct investment to help Openreach deploy new infrastructure if they can't get better and cheaper access to what is built, such as perhaps via wavelength unbundling.

¹⁵⁰ G.fast is a digital subscriber line (DSL) protocol standard for local loops shorter than 500 m, with performance targets between 150 Mbit/s and 1 Gbit/s, depending on loop length. High speeds are only achieved over very short loops. Although G.fast was initially designed for loops shorter than 250 meters, Sckipio in early 2015 demonstrated G.fast delivering speeds over 100 Mbit/s nearly 500 meters and the EU announced a research project. In tests performed in July 2013 by Alcatel-Lucent and Telekom Austria using prototype equipment, aggregate (sum of uplink and downlink) data rates of 1.1 Gbit/s were achieved at a distance of 70 m and 800 Mbit/s at a distance of 100 m, in laboratory conditions with a single line. On older, unshielded cable, aggregate data rates of 500 Mbit/s were achieved at 100 m. The Broadband Forum is investigating architectural aspects of G.fast and has, as of May 2014, identified 23 use cases. Deployment scenarios involving G.fast bring fibre closer to the customer than traditional VDSL2 FTTN (fibre to the node), but not quite to the customer premises as in FTTH (fibre to the home). The term FTTdp (fibre to the distribution point) is commonly associated with G.fast, similar to how FTTN is associated with VDSL2. In FTTdp deployments, a limited number of subscribers at a distance of up to 200–300 m are attached to one fibre node, which acts as DSL access multiplexer (DSLAM). As a comparison, in ADSL2 deployments the DSLAM may be located in a central office (CO) at a distance of up to 5 km from the subscriber, while in some VDSL2 deployments the DSLAM is located in a street cabinet and serves hundreds of subscribers at distances up to 1 km. VDSL2 is also widely used in fibre to the basement. A G.fast FTTdp fibre node has the approximate size of a large shoebox and can be mounted on a pole or underground. In a FTTB (fibre to the basement) deployment, the fibre node is in the basement of a multi-dwelling unit (MDU) and G.fast is used on the in-building telephone cabling. In a fibre to the front yard scenario, each fibre node serves a single home. The fibre node may be reverse-powered by the subscriber modem. For the backhaul of the FTTdp fibre node, the Broadband Forum's FTTdp architecture provides GPON, XG-PON1, EPON, 10G-EPON, point-to-point fibre Ethernet, and bonded VDSL2 as options

¹⁵¹ <https://www.ispreview.co.uk/index.php/2017/08/openreach-consultation-says-large-scale-ftp-roll-cost-6bn.html>

- Today a leaked copy of the consultation has apparently reached The Register, which claims to reveal that such a roll-out could cost up to £6 billion. The leak also suggests that Openreach are considering the possibility of migrating the “entire Openreach customer base” in related areas to new fibre optic lines, which we’d assume would also support the withdrawal of legacy copper line / ADSL services (cost saving).
- However, that sort of migration would be tricky unless the prices between the old and new services are fairly level and all ISPs, not just the biggest players, are willing to play ball. The above article claims might not be the case and customers could end up paying +£7 per month extra for FTTP lines, which would obviously cause a lot of consumer frustration (not everybody wants a faster service, some prefer to save money via slow ADSL). But this is only one of various approaches being considered.

An Openreach Spokesperson said:

- “Deploying full fibre at scale will cost billions of pounds – we are currently in the process of exploring what we can do collectively across industry, government and regulators to minimise those costs.
- The exact costs involved would depend on a variety of factors – which is what the consultation is exploring.
- We also need to consider with [ISPs] what the level of demand for full fibre is, and what the best way is for us to recover the costs of building any network. This process is ongoing, and we will share more detail in due course.”
- At present it’s still early days and no decisions have been made. The consultation itself is expected to run until 29th September 2017 and sadly we won’t be able to see any of the responses because this remains an industry, not public, consultation. Unless somebody leaks those too..
- UPDATE 2:35pm
- We’ve spoken to a couple of ISPs and now have a bit more context for the figures. The document basically says that a large-scale deployment of FTTP might cost £300-600 per premises passed. As such, a rollout to 10 million premises might cost between c.£3bn and £6bn, and a rollout to 20 million premises would cost more than double since costs increase disproportionately as coverage is extended to areas that are more difficult to cover (e.g. rural areas).
- The document also uses some benchmarks to support its point, such as Virgin Media’s £3bn Project Lightning network roll-out to an extra 4 million UK premises that has an expected build cost of c. £600 per premises passed plus £150 per connected customer. Plus, TalkTalk’s joint project in York with a build cost of under £500 per premises, as well as projects in Spain, Portugal, France and Belgium etc.

UPDATE 30th September 2017

- Some recent investor slides from BT (here) reveal that the first 10 million premises to be connected via FTTP would cost an “estimated” £300 – £600 per premises passed, plus £175 – £200 to connect

30. Appendix G: Enterprise and Innovation Impacts of a voucher scheme

30.1 This section sets out the likely enterprise and innovation impacts of a new voucher scheme. This is based on:

- Findings from the GE SME broadband survey
- Findings from the Greater London SME voucher impact survey undertaken by Adroit in 2016 for GLA. This survey used a much more detailed questionnaire and so has more detailed results regarding enterprise/ innovation impacts. We recognise that the London economy and London SMEs are different to GE's, but this said, this does not necessarily mean that GE SMEs will not benefit in the same ways, and to the same extent as London SMEs. Indeed, there is an argument to say that faster better broadband will have more impact on GE SMEs than London SMEs in that it will bring to GE SMEs more of the cluster/ agglomeration benefits felt by London SMEs

GE SME broadband survey findings – enterprise and innovation benefits

- Business-grade services, as well as 'speeds', are a priority
 - = In order of importance, those reporting the need for a better broadband service thought that the things that would most influence better business outcomes were:
 - Quality and stability of connection
 - Faster downloads
 - Faster uploads
 - = Suggesting that reliability and service levels are as great a problem and speeds – **and therefore that the type of connection and the SLA** that comes with is as important as advertised throughput.
- Broadband connectivity is identified as the most important factor in determining future business location (with mobile service connectivity a close second)
 - = This ranks connectivity above utilities, roads, rail, airports; and above access to a skilled workforce
- Respondents anticipated greater productivity and innovation
 - = The three outcomes most anticipated from an improved connection were:
 - Improved productivity
 - Reduced costs
 - Increased levels of product/service innovation
 - = 29% anticipated that these benefits would mostly come from time saved; 20% from increases in sales.

GLA SME voucher scheme survey findings – enterprise and innovation benefits

Summary – Enterprise and Innovation Impacts of a voucher scheme

- Faster broadband directly enables firms to transform their businesses through creating new products, services and processes, and indirectly boosts skills and innovation.

- Using the London voucher scheme survey findings as a benchmark, we have calculated the potential wider enterprise and innovation impacts of the proposed GE 1,000 voucher scheme.

We estimate that the proposed GE 1,000 voucher scheme will enable

- 500 firms to transform their businesses within the first 2 to 3 years of connection to a faster service
- 220 will do this through creating new products and services

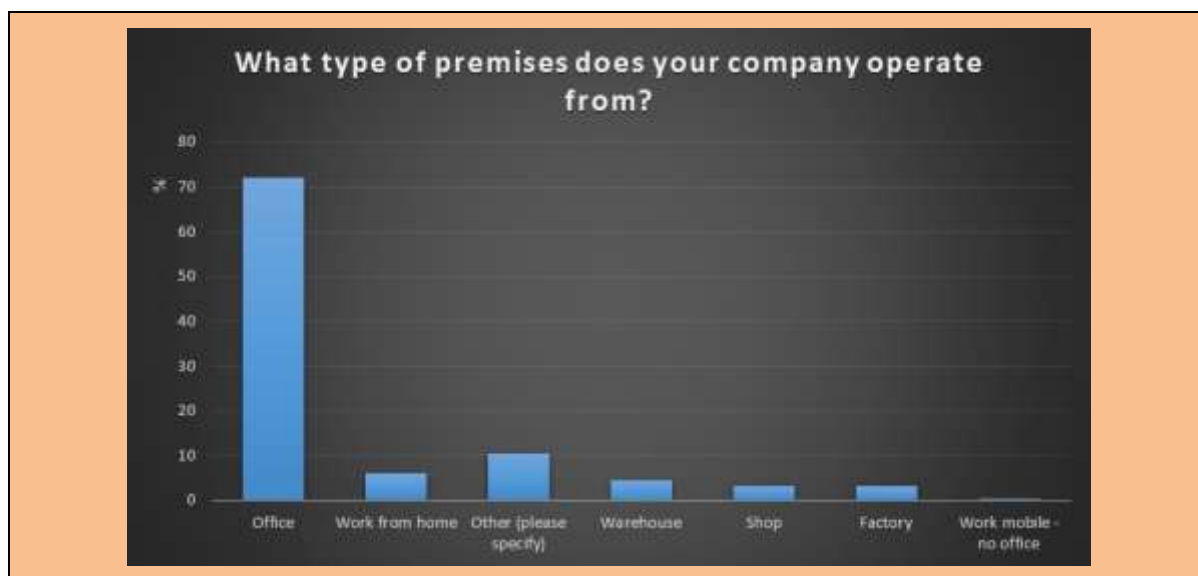
30.2 The London voucher scheme evaluation survey identified a range of what we might term enterprise and innovation benefits to firms. On the assumption that a similar range of benefits will be realized by voucher recipients of this scheme, the following figures show the nature and extent of innovation benefits that might be expected.

Type of premises occupied

- 72% of respondent firms were based in office premises
- 5% in warehouse accommodation
- 3% in shops
- 3% in factories
- 6% worked from home, and
- 1 firm was mobile

Figure 30.1: Types of premises voucher recipients were occupying

Type of premises occupied						
Office	Work from home	Other (please specify)	Warehouse	Shop	Factory	Work mobile - no office
239	20	35	15	11	11	1
72%	6%	11%	5%	3%	3%	0%



Things that firms can do with faster broadband

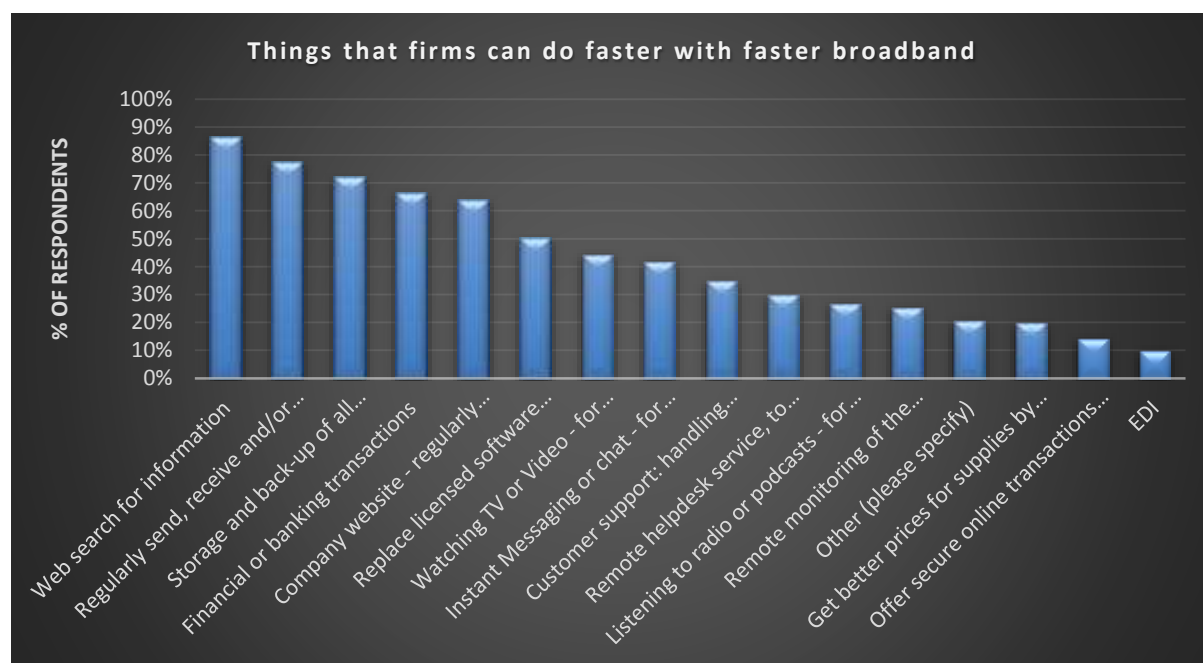
30.3 Firms were then asked a series of questions about what they could do better, faster, or new, with faster broadband:

- 86% said web searching
- 78% said send, receive and joint working with large documents
- 72% said storage and back up
- 66% said financial/ banking transactions
- 64% said managing the company website
- 50% said replace licensed software with online pay-as-you-go software

Figure 20:2 Things firms can do faster with faster broadband

Things firms can do faster with faster broadband	
	% of respondents
Web search for information	86%
Regularly send, receive and/or share and joint working with large documents on line – e.g. MS Sharepoint, Box, Dropbox	78%
Storage and back-up of all company documents and data online ('in the Cloud')	72%
Financial or banking transactions	66%

Company website - regularly updating information/ uploading content, including video	64%
Use of social media - for business purposes	
Replace licensed software products with 'pay as you go' online apps/software (e.g., Office 365)	50%
Watching TV or Video - for business purposes	44%
Instant Messaging or chat - for business purposes	42%
Customer support: handling enquiries from customers or prospects	35%
Remote helpdesk service, to provide end-user support from a helpdesk service provider in another location	30%
Listening to radio or podcasts - for business purposes	27%
Remote monitoring of the workplace (security camera, etc.)	26%
Other (please specify)	21%
Get better prices for supplies by buying online	20%
Offer secure online transactions from your web site	14%
EDI	10%



Ways in which firms might save costs as a result of use of faster broadband

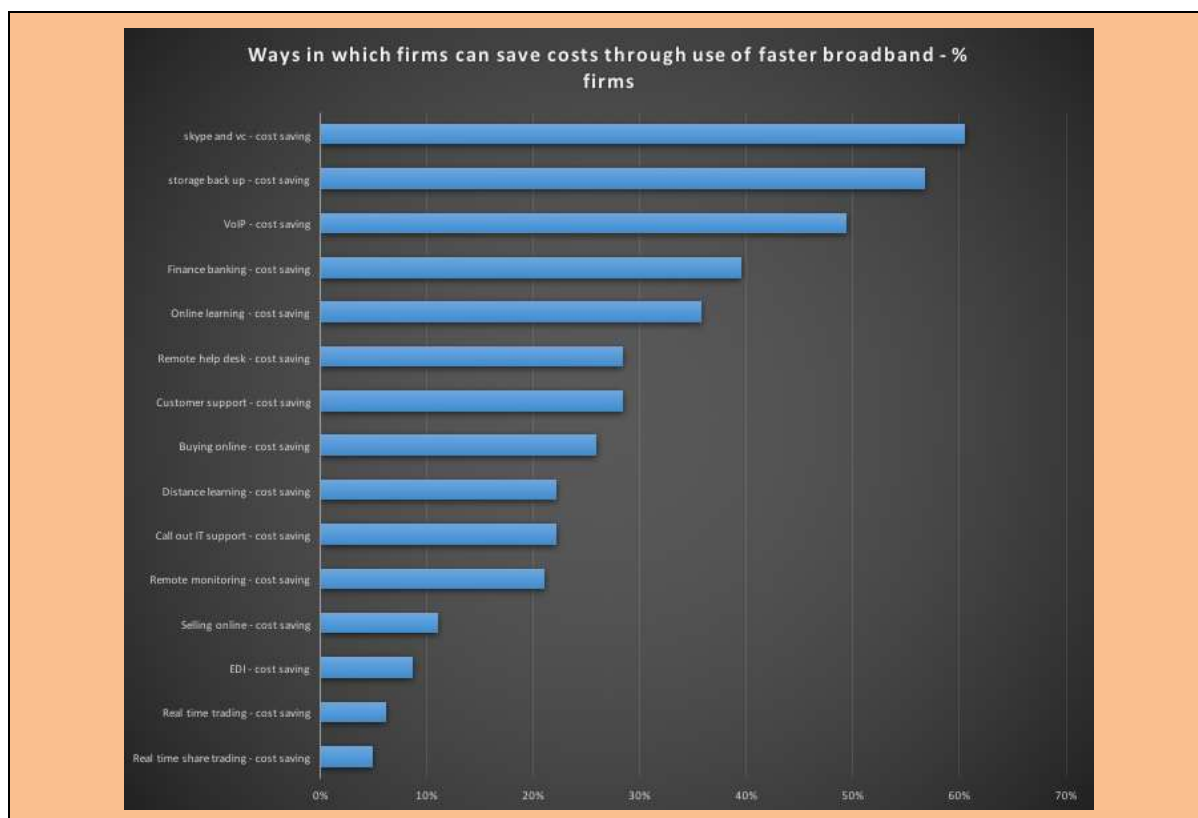
30.4 Firms were asked to what extent faster broadband would enable them to save cost. Figure 9.1 lists the various ways in which firms think that faster broadband will enable them to save money.

30.5 The top 5 examples (i.e. those cited by most firms) were:

- Increased use of skype and video conferencing
- Storage and back up in the cloud
- Voice over IP (IP telephony)
- Financial banking
- Online learning

Figure 30.3: Ways in which faster broadband enables firms to save costs

Ways in which firms can save costs as a result of faster broadband		
Benefit	No responses	%
skype and video conferencing - cost saving	49	60%
storage back up - cost saving	46	57%
VoIP - cost saving	40	49%
Finance banking - cost saving	32	40%
Online learning - cost saving	29	36%
Customer support - cost saving	23	28%
Remote help desk - cost saving	23	28%
Buying online - cost saving	21	26%
Call out IT support - cost saving	18	22%
Distance learning - cost saving	18	22%
Remote monitoring - cost saving	17	21%
Selling online - cost saving	9	11%
EDI - cost saving	7	9%
Real time trading - cost saving	5	6%
Real time share trading - cost saving	4	5%



Ways in which firms might increase sales as a result of use of faster broadband

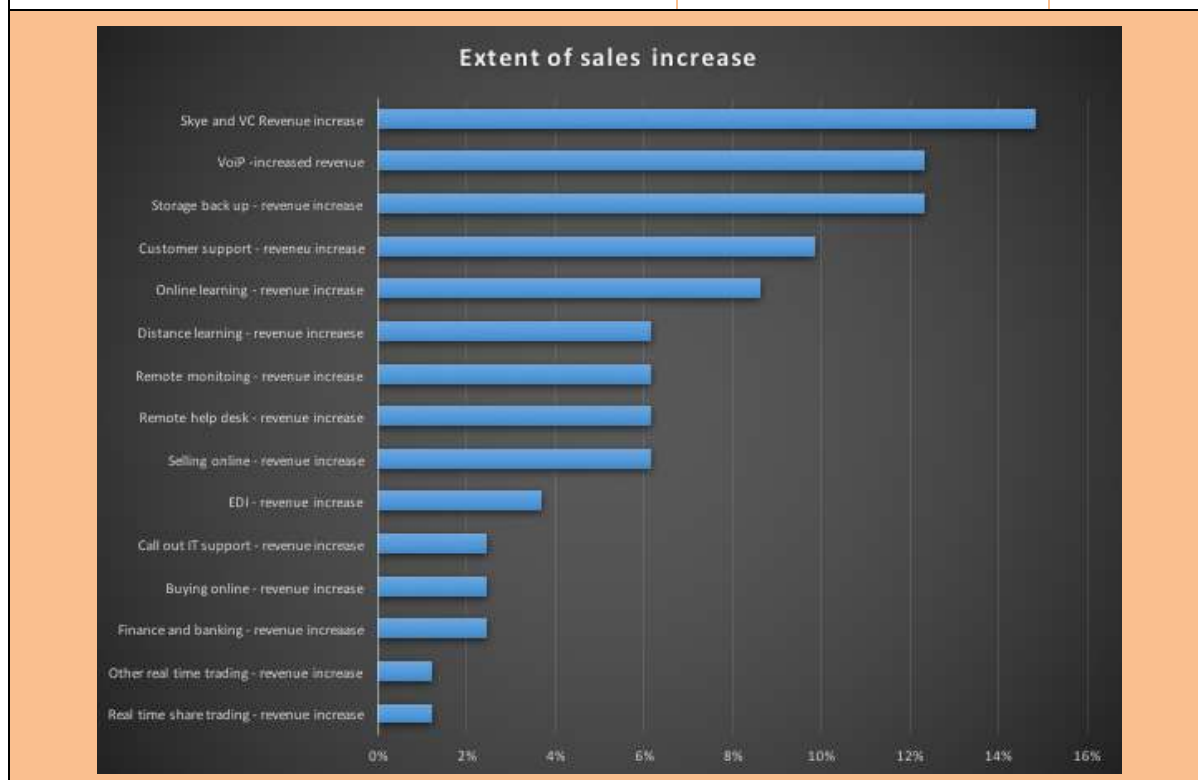
30.6 Firms were asked to what extent faster broadband would enable them to increase sales. The top 5 examples (i.e. those cited by most firms) were:

- Increased use of Skype and video conferencing
- Increased use of online storage and back up in the cloud
- Increased used of voice of IP (IP telephony)
- Customer support
- Online learning

Figure 30.4: Ways in which use of faster broadband enables firms to increase sales

Ways in which firms might increase sales as a result of use of faster broadband		
Benefit	No responses	%
Skye and VC Revenue increase	12	15%
Storage back up - revenue increase	10	12%

VoIP -increased revenue	10	12%
Customer support - revenue increase	8	10%
Online learning - revenue increase	7	9%
Selling online - revenue increase	5	6%
Remote help desk - revenue increase	5	6%
Remote monitoring - revenue increase	5	6%
Distance learning - revenue increase	5	6%
EDI - revenue increase	3	4%
Finance and banking - revenue increase	2	2%
Buying online - revenue increase	2	2%
Call out IT support - revenue increase	2	2%
Real time share trading - revenue increase	1	1%
Other real time trading - revenue increase	1	1%

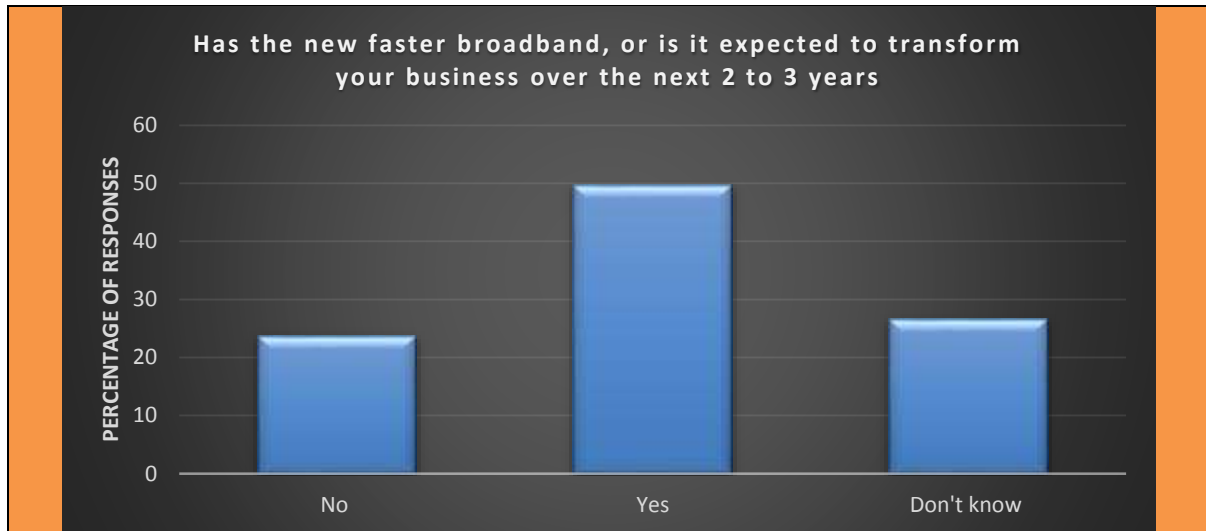


Business transformation

30.7 Firms were asked whether faster broadband would transform their business over the next 2 to 3 years:

- 50% said it would

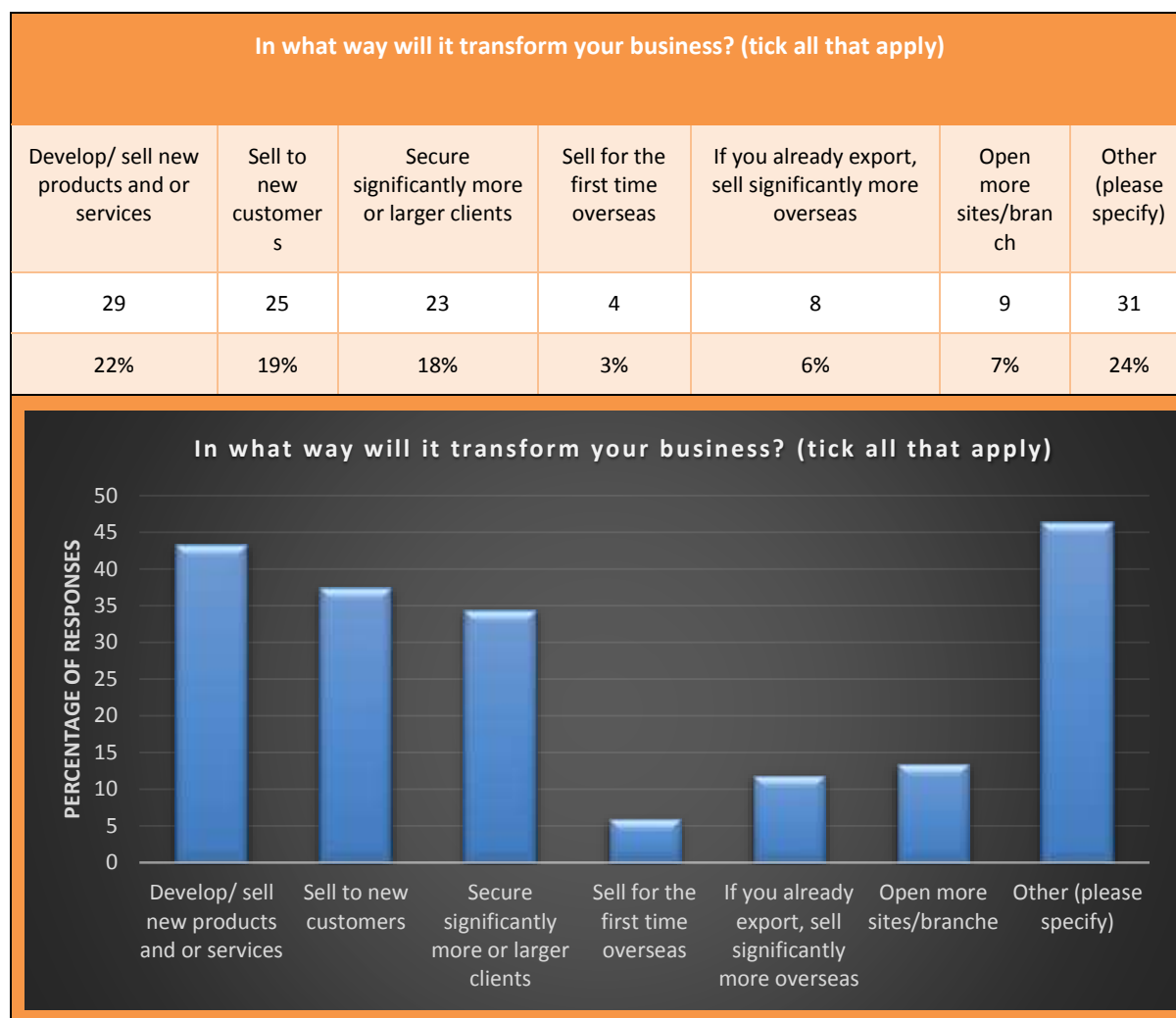
Figure 30.5: Number of firms that thought access to faster broadband would transform their business



30.8 Firms were then asked how they anticipated that faster broadband would transform their business:

- 22% said through enabling development of new products and services
- 19% said enabling selling to new customers
- 18% said enabling selling to more and/or larger clients/customers
- 3% said it would enable selling overseas for the first time and 6% said export more
- 7% said it would enable them to open up more sites/branches

Figure 30.6: How faster broadband will transform businesses



Impact on business if faster broadband was not available

30.9 Firms were asked what would have happened if they had not got the new faster broadband service:

- 70% said they would have lost competitiveness and of these 17% said this would have had a high impact
- 49% said they would have lost customers and of these 9% said this would have had a high impact
- 56% said they would have lost sales and of these 8% said this would have had a high impact
- 47% said they would have lost customers and of these 11% said this would have had a high impact
- 56% said they would have lost turnover and of these 10% said this would have had a high impact
- 40% said they would have had to consider moving premises and of these 17% said this would have been of high importance
- 18% said they may have gone out of business and of these, 2% thought this was very likely.

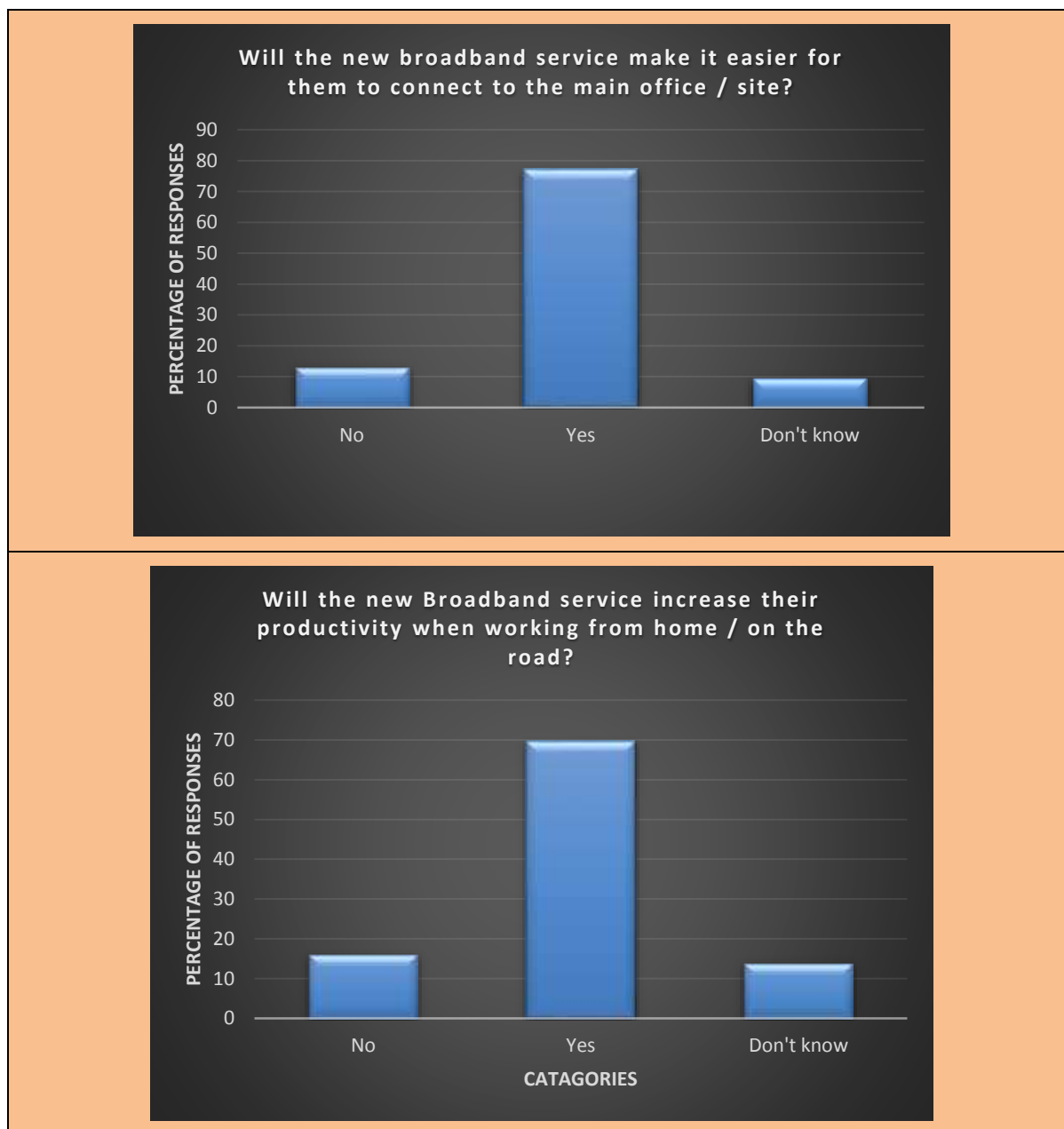
Figure 30.7: Impact on firm if it had not got faster broadband



30.10 Firms with regular home or mobile workers were then asked:

- If the new broadband service will make it easier for these workers to connect to the main office / site – 77% of firms said yes
- And whether the new broadband service would increase their productivity when working from home / on the road – 68% said yes

Figure 30.8: Extent to which faster broadband will make it easier to work from home or on the move, and impact on productivity



Using the London voucher scheme survey findings to estimate the potential innovation and enterprise outputs of a 1,000-voucher scheme in GE

- 30.11 We have used the London voucher scheme innovation and enterprise survey findings to estimate the potential innovation and enterprise outputs of a 1,000-voucher scheme.
- 30.12 50% of firms reported that they expected that use of faster broadband would transform their businesses within the next 2 to 3 years.

Figure 30.9: Innovation and enterprise benefits of faster broadband

Innovation and enterprise benefits of faster broadband. Applying the results of the London voucher scheme survey to a 1,000-voucher scheme in GE		Applying the London survey results to GE 1000 voucher scheme
50% of firms said faster broadband would transform their business	50%	500
Firms also said how it would transform their business		
■ 22% said through enabling development of new products and services	22%	220
■ 19% said enabling selling to new customers	19%	190
■ 18% said enabling selling to more and/or larger clients/customers	18%	180
■ 3% said it would enable selling overseas for the first time and 6% said export more	3%	30
	6%	60
■ 7% said it would enable them to open up more sites/branches	7%	70

30.13 Firms were asked what would have happened if they had not got the new faster broadband service

Figure 30.10: Counterfactual – impact if firms had not installed faster broadband

Impact if firms had not got faster broadband		Applying the London survey results to a 1000 voucher scheme
■ 70% said they would have lost competitiveness ■ and of these 17% said this would have had a high impact	70%	700
■ 49% said they would have lost customers ■ and of these 9% said this would have had a high impact	49%	490
■ 56% said they would have lost sales ■ and of these 8% said this would have had a high impact	56%	560
■ 47% said they would have lost customers ■ and of these 11% said this would have had a high impact	47%	470
■ 56% said they would have lost turnover ■ and of these 10% said this would have had a high impact	56%	560
■ 40% said they would have had to consider moving premises ■ and of these 17% said this would have been of high importance	40%	400
■ 18% said they may have gone out of business	18%	180

and of these, 2% thought this was very likely.		
77% of firms said that faster broadband will make it easier for home and mobile workers to connect to the main office – 68% said it would increase their productivity.	77%	770

31. Appendix H: List of ultra-fast investments around the UK

31.1 Point Topic report the following key points in their *Superfast UK: investing in ultrafast Part I – the infrastructure builders - A report from UK Plus (September 17)*

- At 37 per cent of total lines connected, non-BT ISPs are increasingly represented on the Openreach FTTx¹⁵² network, which now passes 26.8 million UK households. The infrastructure operator is supplying over 100,000 live connections via FTTP and G. Fast, now available to 550,000 premises
- Openreach is consulting with industry on how best to deploy increasing levels of FTTP. The technology is being used more frequently in remote areas under BT's Community Fibre Partnership scheme, which has signed with 350 communities covering 45,000 premises
- Virgin Media's Project Lightning has added almost 800,000 properties to the cable operator's network which passes 13,675,600 premises. Over £200 million is being invested in network capacity to meet the growth in data consumption and maintain service quality
- In the speed stakes Voom Fibre has been launched for Virgin Media Business customers providing download speeds of up to 350Mbps, as the operator continues to grow its SOHO ¹⁵³base
- CityFibre recently raised £200 million to expand its fibre metro networks to at least 50 towns and cities by 2020, and to begin building FTTH for the residential market during 2018, initially targeting five cities and one million homes
- Hyperoptic has raised an additional £100 million to expand beyond 350,000 premises making it the UK's largest alternative residential gigabit broadband provider; its ambition is to pass two million premises by 2022 and five million by 2025
- Gigaclear gained further investment of £111 million to increase the build rate of its FTTP networks across multiple counties; it is close to passing 61,000 premises making it the UK's largest rural-focused alternative network operator
- Further investment announcements have been made in the altnet sector including those by ITS Technology Group, Community Fibre and TrueSpeed Communications, against the backdrop of Government announcements on initiatives designed to stimulate investment in full fibre networks – the Local Full Fibre Networks programme (LFFN), the Digital Infrastructure Investment Fund (DIIF) and 100 per cent business rates relief on fibre
- The altnet sector has entered a period of consolidation with the purchase of business park specialist WarwickNet by CableCom Networking; and Venus Business Communications and Metronet by M24Seven
- Signs of maturity are also creeping in with the number of personnel moves between altnets increasing, and more outsourcing and internal reorganisations taking place – these include Gigaclear's contract with Complete Utilities, and ITS Technology Group's regional focus for sales
- • The new build housing market is becoming increasingly competitive with GTC/IFNL battling it out with Openreach, Virgin Media and new comer Grain Connect to provide full fibre networks to residential housing developers.

Figure 31.1: Superfast fixed broadband connections, end-June 2017

¹⁵² Generally refers to 'Fibre to the'...premises, home, building, site

¹⁵³ Small office or Home office

Point Topic – contact Point Topic for further details				
Altnet operator	Project Locations	Technology	Connections at end-June 2017 (estimates in italics) ¹⁵⁴	Total premises passed reported by network operators end-June 2017 (estimates in italics)
Ask4	Leeds	FTTB ¹⁵⁵	1,257	4,266
Atlas Communications	Middletown, Northern Ireland	FTTC	50	150
	Arc apartments in Titanic Quarter, Northern Ireland	FTTB	400	474
Aylesbury Vale Broadband	North Marston and Granborough in Buckinghamshire	FTTP	100	300
Bridge Fibre	Various business parks including Bristol, Cambridge, Glasgow, Norwich	FTTB	500	700
Broadband for the Rural North (B4RN)	Lancashire, phase 1	FTTP	3,286	8,500
Openreach (BT Group)	Enabled exchange areas	FTTC	8,003,500	26,800,000. 435,000 homes and businesses have access to FTTP
		FTTP	130,500	
Call Flow Solutions	Various	FTTC	2,300	15,000
Chess Telecom (acquired Isrighthere)	Leeds, Liverpool, London	FTTB	719	1,079
CityFibre Holdings	Bournemouth	FTTP	250	21,000
CityFibre Holdings	Various cities	FTTP	3,962	280,000
Community Fibre	Westminster	FTTB	2,000	8,500
Connect Hull (part of MS3 Networks)	Kingston upon Hull	FTTH	50	500
Connexin (took over assets of NextGenUs UK CIC)	Ashby de la Launde, Lincolnshire	FTTP	60	65
Cybermoor	Cumbria	FTTP	50	100

¹⁵⁴ The fourth and fifth columns provide two alternative measures of network rollout (4th) refers to actual connections made to customers based on customer orders (5th) is a wider measure of network rollout and refers to premises that could connect if they wished to, in that the network now ‘runs down their street’.

¹⁵⁵ Business

Grain Connect	Aberdeen, Cockermouth	FTTP	75	100
Gigaclear	Various in 13 counties	FTTP	11,592	29,277 built, 31,682 nearly complete
Fibre Options	Derwenthorpe	FTTP	370	370
	Greenwich	FTTP	484	1,330
	North West Bicester	FTTP	90	160
	Overbury	FTTP	35	90
FizzyLiving	Four sites in London	FTTB	100	246
G-Ti	Gateshead	FTTP	80	80
Hampshire County Council	Villages of Smannell, Little London and Enham	FTTC	30	53
Herefordshire Community Networks CIC	Dewsall Court and Callow in Herefordshire	FTTP	30	44
Hyperoptic	London various sites	FTTB	105,500	350,000
IFNL/GTC	Various sites	FTTP	20,000	20,000
Internet Connections Ltd	St Edwards in Cheddleton in Staffordshire	FTTC becoming FTTP	50	350
	Leekbrook near Leek in Staffordshire	FTTC	20	190
ITS Technology Group	Hammersmith & Fulham	FTTP	1,500	75,000
KCOM	In and round Kingston upon Hull	FTTP, FTTC, FTTN, ¹⁵⁶ FTTB	47,853	132,500
Keycom now called Relish and owned by UK Broadband	London including Kings Chelsea in London via Vision Fibre Media, York via CityFibre, Edinburgh	FTTB, FTTP	1,200	4,000
MediaCityUK	Salford Quays in Salford, Greater Manchester	FTTB	328	378
Sky	Basingstoke	FTTH	120	120

¹⁵⁶ Fibre to the node (FTTN) is one of several options for providing cable telecommunications services to multiple destinations. Fibre to the node helps to provide broadband connection and other data services through a common network box, which is often called a node. <https://www.techopedia.com/definition/26908/fibre-to-the-node-fttn>

Sky	Swadlincote in Derbyshire	FTTH	500	4,000
Solway Communications/T ripleConnect	Crindledyke Farm, Carlisle	FTTH	70	100
TalkTalk in York with CityFibre and Sky	York	FTTH	3,780	14,000
TrueSpeed	Priston, near Bath	FTTH	30	90
Velocity1	Wembley, NW London	FTTB	630	630
Venus Business Communications owned by M4Seven	Battersea	FTTB	24	24
Vision Fibre Media	Barbican, London	FTTB	900	2,200
Kings Chelsea, London	FTTB	100	300	
Virgin Media	30 to 330Mbps	Docsis 3 ¹⁵⁷	4,882,500	13,663,500
Woolhampton	FTTP	10	10	
Vtesse Networks (not taking new orders)	Across deployments in Hertford, Rugby, Broughton and Hatt and Higher Pill near Saltash, Cornwall	FTTC	180	1,247
WarwickNet owned by CableCom	230 live business parks	FTTC, FTTP	1,600	7,000
West Whitlawburn Housing Co- operative	Glasgow	FTTP	81	100
WightFibre		Docsis 3, FTTP	4,500	13,000
Several of these operators have additional subscriber lines using non-superfast broadband services				
We have removed Digital Region following network switch-off				
Virgin Media's figure is for two-way homes, residential multiple dwelling units or commercial units passed by the Virgin Media cable network end-June 2017				

¹⁵⁷ Virgin Media's network technology – latest version

32. Appendix I: Examples of BT community/ local partnership programmes

- 32.1 Point Topic's market reports include examples of BT community/ local partnership programmes. Point Topic's September 17¹⁵⁸ market report includes the following examples:

BT and Community Self-Funding Partnership (CFP)

- 32.2 BT is supporting local authority initiatives, including the £1 million Hampshire County Council Match Funding scheme to help communities that are considering a self-funding route to get superfast broadband. BT has announced it will assist any communities in the Hampshire area wanting to explore a community fibre partnership via this approach. In August 2017, residents of a group of 17 properties in Silchester, near Tadley were named as the first to be taking part in the match funding scheme.
- 32.3 On 30 August 2017 it was announced up to 2,000 homes and businesses could benefit from funding to provide superfast broadband to more Northumberland communities through the iNorthumberland programme. Northumberland County Council and BT have agreed a fund of £2.2 million to bring fibre-based technology to *difficult to reach* communities in the county.

BT, CFP and Schools

- 32.4 Point Topic report that as part of its CFP scheme, BT has made £2 million available in grants to benefit local schools. This enables communities in the final five per cent of the UK not covered by fibre broadband rollout plans to apply for a grant of up to £20,000 towards the cost of their new fibre infrastructure, if that new infrastructure could also serve their local school. The grant is available to communities where their proposal for new co-funded fibre infrastructure serves a school that does not have access to fibre broadband or has a low broadband speed typically less than 10Mbps. Grants are subject to a contract being signed within three months of the date of the offer letter. The grant has been open to applications from 28 June 2016 to the point when it gets exhausted and is conditional on the community raising all of the required funding, plus given on a 'first come, first served' basis.
- Recent grants have included more than £3,000 for the village of Ledston near Castleford where the village school, Lady Elizabeth Hastings Church of England Primary School, will benefit from FTTC installation funded by Openreach and the Better Broadband Subsidy Scheme.
 - On 26 April 2017 Armitage Church of England Primary School in Ardwick, Manchester, signed the 250th agreement the CFP programme. The deal includes a £4,900 BT grant to help towards the cost of extensive engineering work to deliver FTTP technology for the school.

BT, CFP and Business Improvement Districts (BIDs)

- 32.5 Point Topic report that BT has also been working with Business Improvement Districts (BIDs). In August 2017 Matt Lloyd, Head of Community Fibre Partnerships said that Openreach was starting to see more BIDs partnering with it to bring superfast broadband to help firms in their area remain competitive.
- One example is the BID established for Sutton Coldfield in the Midlands. Parts of the town centre were not covered in the national, commercially-driven rollout of fibre-based broadband, or included in plans to benefit from the BDUK programme. However, the BID worked closely with BT and its CFP programme to create a superfast network to benefit the whole community. So far, the BID has enabled three new fibre broadband cabinets to be installed in and around the town centre. Businesses that are connected to the cabinets can take advantage of fibre broadband via a service provider of their choosing. The Sutton Coldfield BID is now working with BT to install more fibre cabinets in the town centre.

¹⁵⁸ Contact Point Topic for further details

- Another example is that of Cardiff's shopping centre, Castle Quarter, in the heart of the Cardiff BID area. BT worked with the Cardiff BID committee to create a business case to invest in fibre installation. The committee were clear about the benefits that fibre connectivity would bring to the shopping centre and how it would support the BID's major ambitions for Cardiff. The Cardiff BID signed a CFP contract with BT resulting in four new fibre-enabled cabinets being installed in the Castle Quarter area, which will make superfast broadband available to around 200 businesses in the Castle Quarter by March 2018.

BT and Crowd funding

- 32.6 Point Topic reports that BT continues to encourage crowd funding by communities having teamed up with Spacehive, a crowdfunding platform back in January 2017, as part of its CFP programme. In March 2017 BT cited several communities which had raised funds in this way.
- Berkshire-based broadband campaign group Faster Broadband for Twyford used Spacehive to help raise around £10,000, a target it reached in a few weeks.
 - Similarly, residents of Tattenhoe Park in Milton Keynes used Spacehive in their aim to raise over £2,000 to match fund a grant for faster broadband.
 - Meanwhile residents of Wellow near Bath also secured a community fibre broadband solution for their village via crowdfunding their costs. It took little over a week for their crowdfunding page to attract the amount they needed to cover 90 households in the village

33. Appendix J: Growth and Funding of the *altnets*

33.1 This section outlines recent investments in, acquisitions and mergers of, plus other market activity within the new, fast evolving altnet market. The information is taken from Point Topics's Sept 17 market report¹⁵⁹. This section provides useful background context in that it illustrates the extent of funding and growth in the emerging altnet sector. This is relevant to GE because GE will need to engage in discussion with and soft market testing of the sector regarding potential future public/private local full fibre network funding bids/ initiatives

33.2 Point Topic report that:

- *Recent months have seen a stream of investment announcements for both large and smaller players on the alternative network operator scene, from wholesale provider CityFibre (which has also snapped up Entanet), to urban multi-dwelling unit providers Hyperoptic and Community Fibre, to ITS Technology Group with its fibre and FWA overlay approach¹⁶⁰, and Somerset-based rural provider TrueSpeed Communications.*
- *Meanwhile the sector is consolidating with the acquisition of business park specialist WarwickNet by student broadband specialist CableCom Networking, and the purchase of both Venus Business Communications and Metronet by M24Seven.*
- *There have been several new appointments over the past six months in the altnet community, often with staff coming from other alternative network operators. Players are also grappling with rapid growth and the impact this has on resources and organisational structures. This is creating changes in approach, for instance Gigaclear's contract with Complete Utilities in terms of using third parties on a more permanent basis, and ITS Technology Group's approach to sales and marketing.*
- *The backdrop for this activity is a series of Government announcements on initiatives designed to stimulate investment in full fibre networks, namely the Local Full Fibre Networks programme (LFFN), the Digital Infrastructure Investment Fund (DIIF) and 100 per cent business rates relief on new lit fibre installed since April 2017, to apply to full fibre infrastructure in England for five years. More details on these initiatives will be in our second Superfast UK report to be published shortly.*
- *Meanwhile Kingston upon Hull's KCOM, although not technically an altnet, is fast approaching 50,000 customers to its Lightstream service.*

Two of the most quoted altnets are City Fibre and Hyperoptic

33.3 Point Topic report that:

CityFibre raises capital for expansion and FTTH deployment

33.4 On 5 July 2017 CityFibre Infrastructure Holdings PLC, designer, builder, owner and operator of fibre optic infrastructure in UK towns and cities, announced it would be raising £185 million at 55 pence per share, fully underwritten by Citigroup, finnCap, Liberum and Macquarie, with the intention to raise further proceeds through an accelerated book building process to be launched immediately. In addition, CityFibre said it intended to raise further gross proceeds of up to £15 million through a non-underwritten offer for subscription. It was supported in this by new and existing shareholders, including Woodford Investment Management Ltd which agreed to subscribe for £36 million in shares. The funds will be used to grow CityFibre's network including:

¹⁵⁹ Contact Point Topic for further details

¹⁶⁰ Fixed Wireless Access (FWA) is a method of connecting a subscriber to an electronic communications network (e.g. for broadband Internet access or telephone services) using a wireless alternative to traditional copper cables

- The expansion of fibre metro networks from 42 UK towns and cities to not less than 50 towns and cities by 2020
- The commencement of construction of FTTH, addressing the residential market, in five to 10 UK towns and cities during 2018 – initially targeting five cities and one million homes
- The acquisition of Entanet, a provider of wholesale communications services, for £29 million in cash. This is aimed at accelerating the commercialisation of CityFibre’s fibre assets by giving CityFibre access to 1,500 channel partners, which it says will drive uptake of full fibre connectivity.

33.5 Currently CityFibre has metro duct and fibre footprints in 42 towns and cities across the UK, including 25 of what it says are the top 30 cities outside London, and a national long distance network that connects these cities to data centres and peering points in London. It has an ambition to expand to 100 cities by 2025, thereby delivering “true fibre connectivity” to 60 per cent of the UK’s businesses and 40 per cent of homes outside London. Within this the operator continues to push its Northern Powerhouse credentials. CityFibre’s Gigabit Cities include:

- The operator says that its FTTH trial in York has demonstrated strong demand from ISPs and consumers for gigabit speed FTTH services, and showed the propensity for consumers to switch to FTTH connections. CityFibre is now in advanced negotiations with ISPs that will market full fibre broadband services to consumers, deployed over its networks.
- On 20 September 2017 CityFibre announced a partnership between it, Stirling Council and MLL Telecoms to provide ultrafast fibre access to around 7,000 pupils, teachers and school staff under its Stirling Gigabit City transformation. Primary and secondary schools will be included in the rollout with Allan’s Primary the first to be covered.
- Meanwhile Bristol’s Gigabit City status has reached its first anniversary in August 2017. Service provider Triangle Networks is using the CityFibre network to serve over 80 businesses with connectivity. CityFibre says that thousands of businesses are within reach of its Gigabit City network. It has 69km of full fibre infrastructure running past Filton to Almondsbury and across the city centre.
- In the Midlands, CityFibre announced on 22 August 2017 that local businesses in Leicester and Nottingham would soon have access to its network. According to a Tech Nation Report from Tech City, the body charged with accelerating the UK’s digital economy, Leicester’s digital sector is developing fast as the city becomes a hub for high-tech businesses, supported by the University of Leicester and De Montfort’s University’s Innovation Centre and events such as the Leicester Startup Weekend. Meanwhile, Nottingham has seen recent tech investments including a new £2 million data centre and the creation of a city centre hub for digital tech businesses.
- Connections are said to be available across Leicester to around 2,000 businesses between Ratby Lane in the west and Humberstone Road in the east, via Dane Hills, Frog Island and the City Centre, including the University of Leicester. In Nottingham, up to 3,000 businesses between Wollaton and Carlton are said to be within reach of the new infrastructure. This includes those based in Arnold, Daybrook, Woodthorpe, Forest Fields, Hyson Green, Nottingham Trent University, Queens Medical Centre, West Bridgford and Clifton Boulevard.
- CityFibre is now asking local businesses to register their interest in Leicester and Nottingham with the network due to go live in autumn 2017. Connections can be acquired through service provider Onecom, which is also providing services via Southend and Coventry’s Gigabit City networks.
- In Northampton CityFibre hosted local business leaders, representatives and decision makers in July 2017 to discuss the town’s digital future. In 2016 Northampton was named the best place for

start-ups outside London in the Centre for Cities' Outlook report. This followed a similar event in Milton Keynes in June 2017, and also discussions at Leeds Digital Festival in May 2017.

- On 27 July 2017 CityFibre announced it is partnering with Wakefield-based NGC Networks to deliver ultrafast full fibre connectivity to local businesses. It is hoped the partnership with NGC Networks will spark investment into Wakefield's digital infrastructure as CityFibre looks to develop its Wakefield asset acquired in January 2016. NGC Networks is also using CityFibre infrastructure to deliver to businesses in Bradford and Huddersfield. The official Wakefield launch event is due to take place on 19 October 2017.
 - CityFibre officially activated Southend-on-Sea's Gigabit City network on 24 July 2017, three months after announcing the initiative. The network has been extended from 50km to 63km, bringing a further 100 businesses within reach. Public sector sites in Southend will use the infrastructure with 100 sites joining the network. These include a number of primary and secondary schools, leisure, community and social care buildings as well as sheltered housing sites. A further 40 traffic/CCTV sites are due to be added over the coming months. Service provider Onecom and CityFibre held a business event to mark the network going live.
 - On 18 May 2017 CityFibre announced that the first businesses had been connected to its South Yorkshire network, which covers Sheffield, Doncaster and Rotherham. The businesses are Imperial Automotive and Credit Style, and are being served by service provider Exa Networks, which also provides offerings to businesses in Leeds and Bradford.
 - And on 13 April 2017 CityFibre said that its Edinburgh network now covers the Leith area with businesses including Out of the Blue Arts and Education Trust on Links Place, business and luxury travel service, Cashel Travel and 180Vita Limited being served by Commsworld. However, CityFibre was fined £35,000 by the Scottish Road Works Commissioner in early April 2017 due to a "number of serious failures to comply with road works legislation in Scotland". CityFibre says it has been working closely with the Scottish Roadworks Commissioner, City of Edinburgh Council and contractors to deliver significant improvement.
 - Also in Scotland, on 4 April 2017 CityFibre said that businesses could access its network in Glasgow's new Tontine Building in the heart of the Merchant City, and where it opened its new Scottish headquarters in March 2017. CityFibre started the build of Glasgow's digital infrastructure in November 2016.
 - On 10 April 2017 CityFibre announced it was starting work on its Gigabit City in Maidenhead and Slough. Berkshire-based IT and telecoms specialist BTL Communications will connect businesses across the network. The build will light up 38km of fibre network from Slough Trading Estate to the town centre, and a further 10km across Maidenhead.
 - By the end of March 2017 the first customers had been connected in Reading and Bracknell. The Gigabit City network was launched in late 2016 with telecommunications specialists, BTL, providing the services.
- 33.6 CityFibre has also been making new appointments. On 24 April 2017 it announced that Jatinder Sispal would be Head of Carrier and National Providers, joining CityFibre from BT where he was Head of BT Local Business. Then on 23 May 2017 the operator said it has appointed George Wareing as Sales Director. Wareing has experience in cable and mobile sectors, including at Virgin Media Business and Telecity Group. PT mapping future coverage
- 33.7 At the end of December 2016 CityFibre had 3,383km of network assets in use, up from 743km year-on-year. Service provider relationships totalled 54, up from 41 at the end of 2015. The operator had 3,962 connected premises by end-December 2016, up from 1,200 the previous year. This excludes any residential connections in Bournemouth, where there are about 200 subscribers on its FTTH network,

and York which covers about 14,000 homes with 2,960 live customers. This project is into phase 2 of build.

- 33.8 Targeting a customer base spanning service integrators, enterprise and consumer service providers and mobile operators with a portfolio of wholesale Ethernet and dark fibre services, CityFibre claims its networks “address 28,000 public sites, 7,800 mobile masts, 280,000 businesses and four million homes”. CityFibre says the 280,000 figure relates to businesses located within 250 metres of its network. ISPs using this infrastructure are actually asked to focus on businesses within 100 metres of network. CityFibre can apply excess construction charges or refuse connection if an end user is too far away to be economical.

Hyperoptic gains funding for expansion beyond 350,000 premises

- 33.9 Hyperoptic has also successfully raised additional funding, announcing on 28 July 2017 that it had secured £100 million to accelerate network rollout. The cash injection comes from a consortium of four European banks – BNP Paribas, ING, RBS and Dutch investment bank NIBC. LionTree Advisors acted as exclusive financial advisor to Hyperoptic.
- 33.10 The operator now passes 350,000 premises. This compares with 35,000 premises passed in February 2014, 75,000 in October 2014 and 100,000 in February 2015. This makes it the UK’s largest residential gigabit broadband provider. The company says its ambition is to pass two million premises by 2022 and five million by 2025.
- 33.11 According to CEO Dana Tobak, “Through private funding and partnerships with developers, freeholders, and councils we have hugely increased our footprint – but it’s our customers that have been the biggest catalyst in fuelling our growth. Our customers have really supported us by sharing their experiences with their neighbours, family and friends, which has meant that we have been able to expedite our rollouts across urban centres”.
- 33.12 Hyperoptic continues to target underserved urban areas with fibre to the building, and is also evolving its business model to offer services to sites starting at 25 units. Based upon demand and proximity of its fibre network, it also says it can service smaller sites. The towns and cities it is present in are listed in Figure 7 below.
- 33.13 Hyperoptic has previously received funds of over £75 million. In 2016 the European Investment Bank agreed to provide £21 million to fuel Hyperoptic’s rollout and addressable market expansion. In 2013 Hyperoptic received an equity investment led by Quantum Strategic Partners Ltd, a private investment vehicle managed by Soros Fund Management LLC.

34. Appendix K: The difference between fixed consumer and lease line connectivity

Two types of fixed line digital connectivity

34.1 Digital connectivity services can be divided into two broad types:

- Lease line services – these are dedicated connectivity services, ordered by individual customers – mainly larger firms and organisations. They are installed to order, often with a time delay and customers pay both set up (dig/connection) costs and annual tariffs. Theoretically any capacity and quality of service can be provided, at a price. Generally, lease line services are seen as expensive and out of the reach of ordinary SMEs and households. Lease line services can provide very high capacity, high quality, suitable services. Lease line services have been available since the 1960s, significantly pre-dating deployment and availability of consumer services
- Consumer services – this is what most people mean when they talk about broadband. Consumer broadband services are a relatively new phenomenon, first appearing in the early 2000s. Unlike lease lines, consumer services infrastructure is available, or installed ahead of take up, across entire areas. Consumer broadband services have so far mainly been provided via transmission of broadband over the legacy BT telephone copper network and the cable TV network. Consumer broadband services are based on standardised consumer packages and are relatively low cost (certainly compared with lease lines). Customers at worst usually only have to pay a small set-up/ installation charge and monthly tariffs are very competitive. The downside is that availability of speeds is limited to the type of network infrastructure and transition equipment pre-installed by providers. SMEs and households in areas where no network has been installed (or upgraded) find themselves unable to get a service, or at best can only access a low speed service. Speeds can also vary depending on how many people in the street are online at the same time

34.2 The proposed GE digital connectivity strategy, in line with and reflecting current Government policy, focusses on consumer broadband services; it focusses on measures designed to enable increased investment in infrastructure that will provide faster higher quality services, offering many of the features hitherto only available via more expensive lease line services. Following launch of the Local Full Fibre Network programme, which explicitly promotes investment in full fibre networks, the proposed GE strategy focusses on fibre deployment.

35. Appendix L: Consultation with CDS

35.1 Connecting Devon & Somerset comprises:

- Phase 1: 2013-16 (delivery finished March 2017). Target of 90% premises to 24 Mbps not met because of the increase in the number of premises over the course of the programme.
- Phase 2 (to end 2019): Target of 95% of premises to 30Mbps – includes reinvestment in sub-30Mbps premises from Phase 1
- Phase 2 includes 6 lots; 5 lots awarded to Gigaclear (FTTP, 40,000 premises) and 1 (covering 12,000 premises in North Devon) via Airband fixed wireless.
- Universal Service Obligation – not an obligation on local authorities, nor for the CDS programme, although this hasn't been clarified by DCMS; not planning to subsidise it.
- The commercial coverage of Exeter City suggested by Openreach in successive Open Market Reviews has not been delivered across wide areas of the city. Therefore, a subsequent OMR in June 2016 has been used to derive intervention area for Gigaclear.
- Openreach is now going back and upgrading non-targeted 'white' NGA areas. As a result, CDS is now planning to revise the OMR and use funding from gainshare on BDUK programme and LFFN funding to cover remaining 'white' areas.
- Heart of the South West LEP (HotSW) has £2.5m of Growth Deal funding for a 4G coverage project – Broadband Access Strategies (consultants) doing coverage assessment to establish pilot areas, based on an assessment of outdoor-only coverage done in 2016. HotSW had to sign NDAs with each of the 4 main MNOs, plus Arqiva, who don't operate standard and comparable models. Ofcom has now signed NDS with the MNOs to provide a local authority-accessible portal. Data for 2016 should be available by end 2017; 2015 data shows 7,000 premises across Devon & Somerset (including the new town of Cranbrook) unable to receive either indoor or outdoor 4G coverage (or both) – although this doesn't mean that all operators will reach all premises, so local authorities continue to receive complaints from people on the 'wrong' network in areas that are notionally covered.

35.2 BDUK's Mobile Infrastructure Project (MIP), which tried to enforce mast sharing on MNOs, was widely held to be a of limited success if any. Plus HMT doesn't want to have to notify any further EU state aid before Brexit, so relying on Article 56 (block exemption) terms. So CDS looking at two options:

- Procure, along lines used by CDS, on basis of an OMR (although they are unclear about the definition of the OMR) to create an intervention area within which funding will be prioritised to those who are totally digitally excluded;
- Just extend 4G coverage

35.3 The operator view (based on Gigaclear precedent) is to promote community ownership of assets through a voucher scheme; but this presents challenges in terms of best value for public money, and therefore procurement.

35.4 CDS awaiting outcome of Ofcom consultation on proposals to permit greater use of repeaters – which would offer a way to improve indoor 4G coverage.

35.5 Satellite: Following a relatively successful pilot on Dev/Som border in 2012, but which threw up usual issues of latency, contention etc, CDS didn't get directly involved in BDUK satellite pilots, other than to identify two areas (Priddy, in the Mendips; Exmoor). CDS can't invest directly in either satellite or 4G, as neither is an eligible NGA technology; but the preferred option is to use 4G and fixed wireless in

those areas which will still be subject to USO following end of BDUK broadband intervention, as satellite is unpopular and politically a 'hard sell'.

35.6 Overall approach to LFFN and further funding summed up as 'don't reinvent the wheel':

- Analysis of what planning tools local authorities have
- Look at land ownership (through VOA data) to identify potential mast sites
- Take into account new build
- Look at other hurdles to developers
- In terms of access to data to support our work, he acknowledged that there were some constraints – particularly in respect of phase 1 BDUK data – but that it could be done through specific requests, case by case, rather than as part of a 'blanket' request.

36. Appendix M: Local Digital Exchanges – CBN model

- 36.1 Full-fibre and 5G network deployment can benefit if there are neutral ‘meeting places’ for connectivity to converge and for networks to exchange traffic.
- 36.2 Like any marketplace or trading exchange, an exchange point is an agreed, neutral place to meet. The creation of Internet exchange points is a contributor to the development of thriving digital business sectors. By providing a neutral place for networks to meet, the Digital Exchange offers carriers and larger ISPs access to local market demand for Internet and long-haul bandwidth, while offering local digital businesses and ISPs access to competitive supply.
- 36.3 Successful exchanges are near the markets they serve. Early investment in Internet exchanges in places like London, Amsterdam and Manchester went ahead of clear demand signals for those services, but explains why these cities developed as Internet hubs, offering low-cost Internet ‘transit’ and hosting and supporting the development of digital and tech-creative business, and why other cities didn’t.
- 36.4 As the digital economy has grown and diversified, a double benefit is possible if new exchange points are located near clusters of demand from digital businesses, both for connectivity and local hosting space. The subsequent success of those early Internet exchanges named above has been accelerated by increasing demand from the businesses that have grown up around them.
- 36.5 Using a neutral, shared governance and ownership model, such as a cooperative, ‘digital exchanges’ of this kind can help competing digital businesses and service providers to capture more of the value chain and underpin the business case for investment, while at the same time encouraging collaborative innovation.
- 36.6 Agreement on a shared, neutral location – one that brings together hosting space and connectivity from multiple providers in a facility not owned by a single carrier – is a critical success factor in securing the participation of a local authorities, ISPs, other service providers and network investors, creating a vibrant market for connectivity and services and stimulating demand that in turn strengthens the business case for investment in new local fibre and wireless network infrastructure.
- 36.7 Digital Exchanges can be publicly funded as part of a regeneration initiative, or sit alongside private or public investment in data centre capacity.

The problem and the opportunity

Full fibre and 5G networks need new, neutral exchange points

- 36.8 The Internet is an ‘Inter-net’, made up of smaller networks¹⁶¹ that exchange traffic using an agreed protocol (IP). This structure has been a principal factor in the rapid growth of the Internet, its capacity to support innovation, and its resilience. You don’t need permission to develop a new application using the Internet protocol, and you don’t need permission to connect a new network and exchange traffic with everyone else. Once on the Internet, packets of data can take multiple routes to their destination depending on current traffic and network conditions.
- 36.9 In the UK most broadband Internet services are delivered through telephone or cable TV connections - networks that were built in the 19th and 20th centuries - or through the cellular wireless networks. These are monolithic, hierarchically structured networks, generally owned and operated by a single supplier. They are less open for competition and innovation, and generally less resilient, than modern fibre-based networks built on the principle of the Internet protocol.
- 36.10 Now the UK is embarking on the construction of new full-fibre and 5G networks better to connect people with the Internet and serve future needs. Networks need aggregation and exchange points. To

¹⁶¹ known as autonomous systems

support rapid deployment of these new networks, they will need new shared, neutral exchange points where they can connect with each other and with the rest of the Internet.

Exchange points can provide a focus for innovation and collaboration

- 36.11 Like a marketplace or trading exchange, an exchange point is an agreed, neutral place to meet. Successful exchanges are near the markets they serve, and successful Internet exchanges in places like London, Amsterdam and Manchester have grown alongside thriving digital business sectors.
- 36.12 The agreement on a shared, neutral location is a crucial first step in making a successful exchange point. By agreeing on a place where local networks can meet and connect with the rest of the Internet, interested parties such as local authorities, ISPs and network investors can improve the business case for investment in new local fibre and wireless network infrastructure. By choosing a location where digital businesses can cluster, a virtuous circle can be created: demand for connectivity attracts competing carriers and ISPs, which in turn makes the exchange point an ideal location to host Internet applications and services.
- 36.13 This type of virtuous circle explains why some major cities like Manchester developed as Internet hubs, offering low-cost Internet 'transit' and hosting and supporting the development of digital and tech-creative business, and why other cities didn't.
- 36.14 With the deployment of new, dense, full fibre and 5G networks, similar virtuous circles will distinguish the districts, suburbs and smaller towns that will attract innovative digital and tech businesses, from those that won't.

The solution

A Digital Exchange is a place for Internet supply and demand to meet

- 36.15 The Digital Exchange concept combines three elements to kick-start and drive the virtuous circle:
- A neutral place where networks can meet, close to an existing or potential cluster of digital and tech businesses;
 - A shared space for local digital and tech businesses to locate servers to support applications and services;
 - A mutual ownership and governance model to guarantee neutrality and support collaboration.
- 36.16 By providing a neutral place for networks to meet, the Digital Exchange offers carriers and larger ISPs access to local market demand for Internet and long-haul bandwidth, while offering local digital businesses and ISPs access to competitive supply. Such a place, where networks meet, is an ideal location for local hosting and caching of content and applications. Local digital businesses that want to capture more of the value chain can access the infrastructure they need to create new products and services. The mutual ownership model, used by major Internet exchanges such as London Internet Exchange (LINX) as a way to ensure neutrality, provides an additional stimulus for local collaboration and innovation in new products and services.

The outcome

- 36.17 Brighton Digital Exchange (BDX) is the first of its kind. A small co-location facility is connected with fibre to 90 business units in New England House, at the heart of Brighton's digital and creative quarter. The facility is 'N+1' resilient¹⁶² with battery and diesel backup and redundant air conditioning. BDX is not a substitute for larger data centres, but offers smaller businesses access to low cost and local hosting.

¹⁶² N+1 redundancy is a form of resilience that ensures system availability in the event of component failure. Components (N) have at least one independent backup component (+1).



36.18 BDX is owned and run by a co-operative. Members can locate servers, routers and switching equipment in the facility at attractive rates. Currently members have between them commissioned three upstream fibre routes to the Internet.

36.19 The construction of BDX was

- funded by central government grant through Brighton & Hove City Council, which owns New England House.
- The seven members of the co-operative compete with each other to provide connectivity and hosting services to customers in New England House and Brighton. Tenants in New England House have access to un-contended 100Mbps, symmetric broadband for £15 per month. But in working together to run the shared facility they have found opportunities to collaborate, create new joint products, and refer clients.

Digital Exchanges and CBN¹⁶³

36.20 CBN pioneered the Digital Exchange Model and worked with Wired Sussex and Brighton & Hove City council to create BDX, including fund raising, state aid clearance, business model design, technical specification and design, project management, and creating the co-operative. CBN is now working with Tameside MBC on a second DX in Ashton-under-Lyne.

36.21 Digital Exchanges can be publicly funded as part of a regeneration initiative, or sit alongside private or public investment in data centre capacity. A Digital Exchange provides an engagement mechanism for ISPs and carriers to work with new networks and will sit ideally at the centre of a network built using the Thin Layer Model advocated by CBN.

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¹⁶³ Community Broadband Network – a broadband co-operative working with a number of local authorities, city authorities and rural partnerships to help set up and operate new alternative forms of digital connectivity procurement, investment and operation, designed to maximise benefits, and reduce costs to local communities and local public sector organisations

37. Appendix N: Cybermoor

Following are extracts from Cybermoor's own case study

Fibre To The Home for the Rural community of Alston Moor

- 37.1 Alston Moor is a rural community located in the North Pennines Area of Outstanding Natural Beauty in Northern England. It is the most sparsely populated parish in England, centred on the small town of Alston with surrounding villages and hamlets.
- 37.2 At a time when first-generation broadband was not available to remote communities and people had to travel a distance to access basic Internet services, the community set up its own broadband initiative called Cybermoor. The original project and funding provided a wireless broadband network to approximately 350 homes and businesses in Alston and nearby communities as well as a community website.
- 37.3 Building on the success of the Cybermoor, a new social enterprise was established, Cybermoor Networks Limited (CNL) to provide a basis for investment in a next generation broadband infrastructure for the Alston Moor community. As a social enterprise, its aim is to develop digital infrastructure for the benefit of the community.

The Need for Next Generation Access

- 37.4 The existing broadband wireless network was challenging to maintain in the harsh environment and users typically achieved speeds of up to 2Mbps/sec download. This was inadequate for the next generation of services to citizens and local businesses. Higher speeds and high reliability access was needed to ensure the community was not left behind the urban areas of the UK. The infrastructure needed to support increased multi-media and bandwidth hungry applications from multiple user devices as well as support important services such as e-learning and e-health. A next generation infrastructure deployment within the community needed to meet the following objectives:
- To provide a infrastructure network to facilitate faster and high broadband connections to homes and businesses: initially 25Mb/sec, with capacity to provide higher bandwidths in the future.
 - To improve the productivity of Alston Moor's businesses, enhance children's education, enable access to the latest Internet applications at home and provide elderly and other needy residents with telehealth services.
 - To attract people and businesses who want to live in a rural area and need access to high-speed connections.
- 37.5 An initial fibre dig was carried out to understand the challenges and issues when providing broadband services over fibre which allowed Cybermoor to sensibly plan the roll out of next generation access. This was quickly followed with an evaluation of fibre cabling solutions from two leading suppliers.
- 37.6 A decision on which fibre solution to deploy was to be based on the following criteria:
- A solution that minimises the capital cost of deploying the cabling infrastructure specifically the civil engineering work and engineer time.
 - A solution that minimises operating costs specifically installation and support at point of delivery - the final few meters across to the customer's premises and through the wall of the house.
 - A solution where individuals from within the community can be used with minimal needs for upskilling.

- 37.7 “We chose the Corning FTTH solution¹⁶⁴ because this was easier and less costly to design, deploy, support and manage”

The FTTH Solution

- 37.8 Funding for the network was raised through a community share offer, DEFRA and Dept for Culture Media and Sports.
- 37.9 For the centre of Alston, Cybermoor chose to deploy Corning FTTH Pre-connectorised Outside Plant System. This enabled Cybermoor to significantly reduce the costs of network design and deployment as well as the customer installation. The modular, pre-connectorised solution provided a faster and easier way to deploy the network and for individual customer connections to be made.
- 37.10 Alston has many small cobbled streets that are costly to excavate and reinstate at around £200 per metre. In addition this would have caused lots of disruption to citizens and businesses and is difficult to undertake during winter due to snow and ice. As such, they chose aerial deployment of the optical fibre within the town, running from a head end at the town hall, along the rear facades of buildings and cascading the distribution points along the way. This enabled Cybermoor to minimise the civil engineering work and reduce infrastructure deployment costs by 50 percent.
- 37.11 With the community as stakeholders and a less disruptive deployment, it was easier for Cybermoor to negotiate wayleaves with property owners and the housing associations. Where wayleaves could not be negotiated, the modular nature of the Corning solution enabled quick and inexpensive changes to the network design and deployment.
- 37.12 Pre-connectorisation is employed at the Distribution Point (DP) where network access is provided to each customer and at the customer premise. The DPs use Corning OptiSheath Multiport Terminals which carry the OptiTap®, environmentally hardened connector adaptors. The drop cables are supplied pre-terminated with OptiTap connectors both at the DP end and a field terminated OptiSnap™ connector is fitted at the customer end. Cybermoor deployed the drop cables coiled up at the DP ready to install to the customer premise. A Corning Small Wall Terminal is then placed just inside the home terminated with an OptiSnap connector.
- 37.13 This simple ‘plug-and-play’ approach with drop cables allows customer connections to be provided quickly with reduced labour costs providing significant operational cost savings over the lifetime of the network. The Corning solution enables Cybermoor to deploy the FTTH network using staff with no optical plant experience, specialist knowledge on network design and without any specialised installation equipment. Four individuals from the community carried out the whole design and deployment after being provided with a half-day training course – providing jobs for the local community.

In the South Tyne Valley, Cybermoor used a Rala solution to lay ducts along a disused railway and across fields.

- 37.14 “The rural town of Alston Moor is a great example of what communities can achieve through a social enterprise model and innovative technology. Residents and businesses can now take advantage of high-definition video streaming, faster downloads, teleworking and new community services that will help transform the local economy¹⁶⁵.”

Outcomes and Benefits

¹⁶⁴ <https://www.corning.com/worldwide/en/products/communication-networks/products/fibre-optic-cable.html>

¹⁶⁵ <http://www.cybermoor.org/>

- 37.15 Following receipt of equipment and training, the network was deployed section by section. Around 600 homes have been passed.

Current Status

- 37.16 The network is operated by Quickline, which is the ISP and this model provides the community with a chance to get involved in raising the finance and building the network, but without the long term requirement to run it.

More information at www.cybermoornetworks.org.uk

38. Appendix O: B4RN

Creating a community cash generator – review by Point Topic

- 38.1 Broadband for the Rural North is a phenomenon. The community operator is providing 1Gbps symmetrical fibre-to-the-premises (FTTP) broadband as standard to rural homes and businesses in Lancashire, passing an estimated 5,000 properties and delivering service to over 2,300. It is currently installing around three to four kilometres of new fibre every week and average take up is running at 65 per cent.
- 38.2 Entirely funded by the 53 parishes it serves and taking no direct public subsidies, B4RN has not only broken even financially, it is set to enter a new chapter in its life effectively becoming a cash generator for local projects.
- 38.3 It has been clear for some time that B4RN is about more than just bringing superfast broadband to remote and rural communities. Its model taps into the heart of community action, enabling local people to help themselves, to plan, to organise and to carry out the physical work involved in laying fibre. Once build is complete and service live, some in this army of volunteers choose to continue their B4RN activities becoming involved in customer care and support, as well as helping neighbouring communities deploy fibre.
- 38.4 Continuing to grow beyond the original 3,500 properties it was targeting, B4RN may well end up covering 25,000 to 30,000 homes and businesses, some of which may be located in Scotland along the route of its new fibre link to Edinburgh internet exchange, IXScotland.
- 38.5 But can B4RN continue to expand as part of a solution to address the UK's final five per cent for which superfast broadband is proving elusive? Or has it benefitted from a unique set of circumstances which mean there is a limit to its size and scope?
- 38.6 Point Topic visited B4RN's headquarters in Melling near Lancaster where we met Barry Forde MBE, one of the group's founders and now Chief Executive. Forde explained how the group has achieved what it has so far, how it is adapting to manage its growing coverage and customer base, and offered his view on factors that have enabled the initiative's success.

Background

- 38.7 September 2015 was significant for B4RN – it moved into its own building and took on employees for the first time. This coming of age meant the move from a community organisation run out of volunteers' living rooms, to a fully-fledged entity with offices, internal and external storage facilities, and staff. The operator now employs 14 people based at its headquarters in Melling, around a 25-minute drive from Lancaster.
- 38.8 Broadband for the Rural North Ltd or B4RN as it has been termed was launched in December 2011 by a group of volunteers led by Barry Forde, who has many years of telecoms industry experience. It was registered as a community benefit society with the Financial Conduct Authority. The organisation can never be bought by a commercial operator and profits can only be distributed to the community.
- 38.9 The company's initial share offering raised hundreds of thousands of pounds from the local community and the first dig took place in the village of Quernmore in March 2012. Regularly in the national media spotlight, B4RN has won recognition both in terms of its fibre deployment and as an energised community organisation, including receiving the Internet Service Providers Association 'Internet Hero' award and a visit from HRH The Prince of Wales.
- 38.10 People are absolutely central to the organisation. Forde's background as a UK specialist in networking, particularly wide area fibre networks, means B4RN's network was professionally designed from the start to world class standards, namely fast, resilient, expandable and futureproof. Other founding

members Chris Conder and Lindsey Annison brought experience from local community wireless mesh and fibre networks, while Monica Lee brought management skills. Indeed in 2015 both Forde and Condor were included on the Queen's Honours list and awarded MBEs. The team has since been expanded with new members bringing a diverse range of skills.

The business model

- 38.11 B4RN is a non-profit organisation. It deploys its network into communities which have invited it to do so and which have raised the investment necessary to cover the labour and materials needed to cover that area. Volunteers carry out much of the work with the guidance of B4RN engineers, and support comes from local landowners and farmers. So far local communities have invested £4.8 million in B4RN shares and loans. It has around 1,200 shareholders.
- 38.12 Each community's investment comes predominantly from the issuing of shares in B4RN, the value of which can be ring-fenced for supporting build in that particular locality. Share purchasing is made more attractive through use of HMRC's Enterprise Investment Scheme enabling tax relief of 30 per cent to be claimed, and after three years interest of five per cent can be paid out or reinvested.
- 38.13 The minimum shareholding is £100 and the maximum £100,000, and shares must be held for three years. They can only be sold back to B4RN at £1 each. According to B4RN some shareholders choose to invest £1,500 and claim free connection worth £150. Central to the model is that once a shareholder, that individual is a member of B4RN and receives one vote accordingly. The organisation also takes a limited number of five and 10-year loans from the community, again paying interest at five per cent. In addition B4RN has a business development loan from the Esmeé Fairbairn Foundation.
- 38.14 According to Forde, "Most of the B4RN network is being built by local volunteers and landowners who know their community and the lie of the land. Each area that rises to the B4RN challenge has found it a wonderfully empowering and a socially engaging opportunity. There's nothing like building something for yourself, and having that sense of pride and ownership. In this sense, broadband is just the catalyst and the majority are engaged because of the wider community bit."
- 38.15 Forde believes that within the customer base around 20 per cent want the fast broadband, whereas the majority want the service because they like the idea of supporting a community initiative. "You just need a hard core of broadbanders that can motivate others," notes Forde. "Added to this is that there is no danger of exposure, FTTP is a superior product, and the £30 per month price with no line rental means we are very competitive".

Wayleave permission key to approach

- 38.16 Central to the B4RN model is that of free wayleave permission. The operator specifically avoids digging fibre into the public highway, instead relying "massively" on the generosity and help of landowners and farmers. This combined with the local knowledge and assistance these people can provide with laying fibre, mean it can build an affordable network connecting the most rural properties. "As a community we go to farmers and say this is a social enterprise, any money B4RN makes goes back into community," says Forde. B4RN has code powers from Ofcom enabling it to construct infrastructure on public land when it needs to, for instance, crossing roads.
- 38.17 B4RN has what it says is a simple single page, plain English document wayleave agreement, which gives it permission to install B4RN ducts across a landowner's property. It offers landowners installing duct a 'share for work' claim scheme. It also pays landowners, farmers and contractors £1.50 per metre to install B4RN duct. Work must be approved by local community champions who check it meets B4RN standards, and be referenced by route number and chamber location.

Building an army of volunteers

- 38.18 Forde says that building the network at community level is actually quite straightforward and with guidance and support from B4RN, he believes that anyone can do it. The community's energy and

interaction become infectious and many volunteers choose to stay on and help other areas get up and running long after they themselves are connected.

- 38.19 “And it’s not all about digging holes,” says Forde. In addition to laying duct and installing chambers, volunteers are used for a range of activities including informing the community and encouraging investment, walking routes and agreeing wayleaves with landowners, coordinating site work between volunteers and landowners, advising property owners and helping to install their house fittings, as well as baking for other volunteers – as B4RN’s website says, “Our army marches on tea and cake!”
- 38.20 New volunteers are encouraged to visit B4RN working parties in active areas, and attend presentations in their communities or Show-Tell days. These days are run jointly with manufacturer Emtelle and are free to participants.

Beginnings of a community project fund

- 38.21 In terms of finance, B4RN has gone through hard times with cash flow an issue in the early days before increasing subscriber numbers provided a solid recurring revenue stream to support operations. This has now changed. Current revenue, 2016/17, stands at £750,000; next year, 2017/18, it will be £1,250,000 and the following year it is projected to be £1.75 million. Operational costs are ~£750,000 per year and are not going up, so according to Forde the organisation is able to service its debts. After next year there will effectively be a profit. “The plan was to run down loans in 10 years and pay back 10 per cent of shares per annum,” says Forde. “But people don’t want their shares or loans back as we pay five per cent interest.” This will leave B4RN with a multi-million pound surplus.
- 38.22 The next key question is how to put these funds back into the community, something which will be discussed at B4RN’s next annual general meeting. Forde says, “We are thinking about the idea of community funds for projects – possibly big and little kitties. Little kitties are perhaps based on the number of properties in a parish, with the parish suggesting ideas for funding such as trips for their local nursery school. Then there might be a bigger fund for projects which are bid for, such as a new roof for a village hall. Parishes could vote on a list of projects but would not be allowed to vote for their own project, rather like the Eurovision Song Contest,” he adds.
- 38.23 These projects are clearly not, and need not be about broadband. They also tap into B4RN’s growing volunteer network. “Projects could involve care in the community,” says Forde. “Perhaps we pay £7.50 per hour to a carer, but when you add in transport and costs you could be paying £30 an hour. Yet here we have a structure of volunteers which can be used to transport and to localise this care.”

The journey towards connection

- 38.24 Most approaches to B4RN for infrastructure coverage tend to be made by individuals. These are followed up to gauge how much interest there is in that particular parish. B4RN will only take on a parish if there is agreement from the community that all properties within that parish are connected to the network. It is possible to extend beyond a parish but the golden rule is not to miss any properties out.
- 38.25 If there is clear interest then B4RN will do some early mapping work and arrange an information event, perhaps at the local village hall, providing residents with an idea of the costs involved. These include around £10,000 for a cabinet and about £1,000 per property dependent on the terrain, location of and number of properties involved. One community for example required a 4,500 metre long dig to reach 27 homes at a cost of around £20,000. In another area, Little Strainforth, a local caravan business is paying for all the materials and digging required to reach its site.
- 38.26 If the parish is confident it can raise the funds needed then the project is taken to the next step. According to Forde, communities do not have to raise all the finance up front, “but they need to have a reasonable crack at it”. He adds that it tends to be when B4RN starts putting in duct that residents really start investing.

- 38.27 As mentioned above, funding predominantly comes from the purchase of shares, but parishes are free to raise funds in other ways. For instance Dentdale received a £150,000 grant and raised another £50,000 to £60,000 from residents. There are also properties in the B4RN area eligible for funding under the Government's Better Broadband Scheme and B4RN is a designated provider – these grants will be applied for and then pooled into the community's overall finance pot. In fact build costs are never as much as predicted because volunteers tend not to take all the £1.50 per metre payments offered by B4RN.
- 38.28 The next step is to provide the community with a Google Earth map plotting routes along with costs. Forde says this map is essentially "a straw man done on a desktop", and is designed to invite residents who know the local areas to tell B4RN how best to make deployment work. "We set out plans, then they say go this way or that, so we are getting the community engaged looking at routes and advising from the earliest possible stage," says Forde. Equally important is that this process means the community itself begins to take ownership of the project.
- 38.29 This aspect comes into its own when deployment starts and parishes have to organise themselves. Often a community will split itself into smaller areas with individuals coordinating activities. Garsdale and Dentdale, for example, split the parish into eight or nine zones and appointed an individual champion in each to manage civils activity. Volunteers are given duct (an inexpensive material) and lay small 16mm ducts either by trench or mole-ploughing. The main approach used is mole ploughing through fields, which can be as fast as one kilometre per day. One dig of 3.6 kilometres involving 10 volunteers was completed in a single weekend.
- 38.30 Most ducts are laid under agricultural land, but B4RN does regularly license roadworks where necessary to cross railways, motorways, canals and has crossed under the Lune with Environment Agency approved directional drilling. Further 16mm ducts are installed around the community to a number of buried chambers in which junction boxes called 'bullets' are placed. From these bullets a very small 7mm duct is laid to each property requesting service.
- 38.31 B4RN will never do the last connection into a property. This has to be carried out by the owner or resident. If someone cannot do this for whatever reason, the community will step in and do it for them. "Communities use their judgement as to whether that person is just being lazy or cannot afford to pay for someone else to dig," says Forde.
- 38.32 When the civils are ready B4RN engineers blow the more expensive material of fibre. There are a few very experienced volunteers who can blow fibre, and according to Forde, the organisation is looking at providing kit so that volunteers can blow their own fibre connection to properties. This would allow B4RN engineers to then splice a number of properties in one visit rather than on an individual basis. This would clearly add a greater element of trust to communities involved.
- 38.33 Volunteers attend an induction meeting and are shown how to carry out various activities such as how to do a utilities search and sealing chambers so they are waterproof. And because the vast majority of work takes place on private land there is no issue with Highways and having to use trained professionals. Formal training can be offered but Forde says this can provide too much information for many volunteers. "It is all about common sense," he says. "A volunteer needs to be a person who knows the destination but doesn't have to plan the entire route. As things change they need to be flexible." Most volunteers are aged between 50 to 80 years, likely to be retired, semi-retired or self-employed, with equal numbers of women and men.
- 38.34 Take up levels for B4RN are high. Abbeystead, for example, has 128 properties situated over a huge area involving 43km of digging. The cost was £998 per property and take up stands at 81 per cent. Another community Wray, which is deeply rural and now has a BT cabinet in the village, cost £446 average per property and has an average take up of 73 per cent, with 90 per cent on its Route 3 where 53 properties are signed up.

Service and support

- 38.35 B4RN is an infrastructure provider offering internet access to its customers. It does not regard itself as a service provider; rather an enabler for customers to reach the services they require offered by over-the-top providers. “We do not worry about the services being used,” says Forde. “Our job is to provide a fast link to the internet cloud.” Figure 2 lists the prices B4RN charges for different types of user. Indeed it should be noted that B4RN has not changed its prices since it began offering service.
- 38.36 Holiday cottages, caravan sites, larger businesses and schools, hotels, churches all have special pricing plans that take into account their special circumstances.
- 38.37 Customers are provided with a router which remains the property of B4RN. They can have the network installed and connected immediately or can delay taking service until their existing contract expires. The £150 one-off connection fee is waived if a customer invests £1,500 in B4RN. Contracts are for a minimum of one month after which they can be terminated by giving B4RN at least 10 days’ notice. There are no data caps or traffic shaping. Customers are advised to take a VoIP provider for their telephony requirements.
- 38.38 Places of worship are offered a basic B4RN service for free. Small rural village schools are also given free service. Village halls receive free service for life if they volunteer to host a B4RN cabinet.

Gearing up customer care

- 38.39 As customer numbers grow B4RN has plans to further develop its highly personalised approach to customer care. Currently support is provided from B4RN’s Melling office. But there is a plan to have volunteers resident in local communities connected via VoIP who register on a dedicated website when they are available to take customer calls. Customers are then connected to those ‘online’ volunteers within the customer’s community via the two last digits of the support telephone number assigned to that community. Whichever volunteer is the first to answer the call receives payment from B4RN. Volunteers will be paid a small retainer whenever they are on call.
- 38.40 Most support issues are about Wi-Fi problems within the home. Others calls tend to be from elderly users who have trouble understanding computers. The model of highly localised support is particularly suited to these demands.

Growing the B4RN footprint

- 38.41 The Lune Valley is B4RN country, constrained by the Irish Sea on one side and in the past by the Pennines on the other. This is changing, however, with the operator now expanding over the Pennines and into communities such as Hawes and Wensleydale. The original plan was to cover 3,500 properties in 23 parishes. The core of the network connects Arkholme and Quernmoor, but B4RN has extended its coverage significantly. Figure 3 and Figure 5 illustrate B4RN’s current and imminent coverage. With 53 parishes under the B4RN umbrella the organisation is set to take on another 10 parishes. The coverage plan now is for 20,000 properties with 10,000 to 12,000 customers in next three to four years. At the end of March 2017 it expects to have 3,000 customers.
- 38.42 Forde believes that build potential is such that B4RN could ultimately have 25,000 users. “The business is taking on more than expected each year, so it might go up by 3,000 a year, then 4,500, then 6,000, as build expands out from the radius. We are doing more [deployment] in parallel and also seeing significant infill numbers,” says Forde. The provider is happy to go back to those now wanting service in areas already connected but do say that connection may take a little longer than if they had signed up at the time. Residents always have the option of paying the £150 connection fee and not activating the service, for example if they are in an existing broadband contract.
- 38.43 B4RN now competes in many of its areas with BT’s fibre-to-the-cabinet (FTTC) technology. According to Forde, once B4RN builds in a community BT usually puts in FTTC within six to 12 months, in some cases using Government funding. Although it is frustrating to see public monies being spent in this way,

B4RN welcomes the competition which does not appear to affect its take up rates. With average penetration in the mid-60 per cent range, some areas are at 40 per cent, others are seeing 95 to 100 per cent.

Network installation

- 38.44 B4RN is a point-to-point fibre-to-the-premises deployment delivering fibre directly into each property connected to what is effectively a mini exchange or node in the community with active electronic equipment inside it.
- 38.45 The 'node' cabinets can each serve 600 premises and are specifically designed and made in the UK for the operator as shown in Figure 6. They are now kitted out in B4RN's premises, speeding up deployment compared to in the field because engineers have everything to hand and weather issues are eliminated. The result is it takes just two to three days to complete a cabinet.
- 38.46 Cabinets can be hosted inside community buildings such as a village hall or in custom built secure outdoor enclosures. They fall under permitted development rights for planning purposes because of their small size. Every service cabinet has two routes connecting it meaning there is a back-up connection in case of damage to one of the routes. Batteries provide a four hour reserve, and the cabinets have a socket for a generator. If power fails the cabinet automatically sends an SMS alert and a local volunteer can bring a generator on site to plug in.
- 38.47 These local nodes are connected by two feeds into the wider network to provide redundancy. Juniper routers are used. B4RN has a 10G fibre to Manchester's internet exchange IXManchester and another 10G link to LINX in London. It commissioned a 10G link in November 2016 to Edinburgh's internet exchange, IXScotland to ensure greater resiliency in its internet connections. According to Forde a balanced network is vital to be able to access the outside world and backhaul, where there is IP transit, peering and resilience. He says this is not being driven by profit but the community wanting the best possible service for the community. "It is really world class," Forde adds. "This is something that B4RN always wanted but before we didn't have the money, now we have."
- 38.48 Resilience of the network was tested during winter 2015/16 flooding when 66,000 homes in the area were without power. B4RN was pleased how the network responded. Hubs in locations with no power continued to work as planned.
- 38.49 B4RN has seen usage triple in a year with traffic peaking at about 8pm. It also sees spikes in traffic at night when cloud uploads are taking place. However this is not a problem in terms of capacity because uploads take place so quickly, for instance, 1G will take up only five per cent of any given node. Forde says B4RN is therefore prepared for 4K TVs, which at 25Mbps each can easily be catered for on the operator's 40G circuit. "People used to work with a dribble, but we are now seeing large volumes due to 4K TVs and expect a surge in January," says Forde. "We rely on gross overprovisioning rather than managing." If B4RN finds that a particular content provider is responsible for a lot of traffic it will peer with that organisation via IXManchester. This applies to both Akamai and Netflix for example.
- 38.50 Forde says that future proofing the network was essential to the B4RN project right from the start. Speaking earlier this year at INCA's Gigabit Britain conference Forde stated: "The key is to have a vision people will buy into. This is not a short term temporary solution; you need to shock and awe people in the community with something that has a long term life, is state of the art and will stay state of art for 50 years. So we went for FTTH, building for several generations. In rural areas people do think long term; they do not like replacing things, so we went for pure fibre buried from day one." As broadband demand long term grows further, B4RN will enable DWDM and CWDM technology in order to raise capacity through wavelength multiplexing.

Unique approach or a model for others?

- 38.51 In the context of the Government's recent declared enthusiasm for fibre all the way to the premises, Forde is confident B4RN has played a significant role. "B4RN has shown it is possible to fibre the last five to 10 per cent without costs going up exponentially, and that in fact costs go down," says Forde. "We are doing the last five per cent for £500 to £1,000 per property. We do the outer bits but we need to pick up the busier parts to keep the price down in terms of numbers."
- 38.52 This is because B4RN's model is different to commercial approaches including BT's. "We enlist the community to put in the work. Rural communities have a 'can do' attitude. We give them the model, it is their money, they are helping the community, they are making a difference, and they end up owning it." According to Forde, "This works because it is where they live, it is about their neighbours. You can be in the same county council area but still have no sense of affinity with other areas. But in B4RN's case they do wish to help the next village."
- 38.53 Forde believes it is important to give the project an ending in terms of the time required by volunteers. "My experience is that the vast majority of people like to get on with everyone else, so you are selling the idea of a community. And you give people a project bounded by time that is not open-ended, and they can hand it back to B4RN at the end to run it. It happens to be broadband but this can be the same with other things," he adds.
- 38.54 A small proportion of volunteers adopt B4RN as their main aim, hobby or even career. "These ones carry on and number perhaps 100 or 120 people which we can call on out of perhaps 1,000 to 2,000 volunteers over time," says Forde. "These may be the ones who take on the customer care role, perhaps have a generator in case of power cuts, or who will go into neighbours to help sort out problems."
- 38.55 Forde is also clear that local government involvement is not the best approach for rural broadband. "Every government department is siloed and not does work in a holistic way. This is the mindset of local government, the Highways being one example of how rules are used to prevent progress."
- 38.56 He believes this partly explains why some other community groups have not proved successful. "They are inevitably looking for public money but this is hard and time consuming to get." Forde also says that commercial and community models should not be mixed. Funding is not the issue, he adds. Instead Government needs to make the environment more sympathetic for community groups, "To knock down some of the barriers." Forde welcomes Ofcom's dark fibre remedy which he says will help with backhaul. But he believes that more could be done to encourage regional peering centres, and to seed corn this approach.
- 38.57 He also believes that Government needs to give community plans breathing space from BT and welcomes the Government's Digital Infrastructure Investment Fund. "Community groups need a window of 18 months to two years to their enact plans. There needs to be a fundamental change in community broadband."
- 38.58 But Forde also acknowledges the importance of individuals in community projects. "I think my background is a big help – our plans were believable and we knew we could do it. You have a story you can tell people, a vision that is futureproof. And B4RN is now turning into a cash machine."
- 38.59 So is there an opportunity to expand B4RN further in UK? Forde thinks so but this may not be B4RN itself. The operator certainly has plans to move into Scotland breaking out into communities on its new fibre route to Edinburgh.
- 38.60 But there is a challenge not to become too distant from the communities it serves. Forde says B4RN will probably not get bigger than 25,000 to 30,000 premises covered, comprising what are very large geographic areas. But this could be a federation model, perhaps with B4RN being paid to provide the expertise and tools to enable other communities.
- 38.61 "There is a need to have groups adapt to local conditions; and to bring in new genes," says Forde, Indeed the governance of B4RN may move towards involving an advisory group made up of representatives from each community that meets say twice a year.

- 38.62 “We now have the numbers, the critical mass, zero churn, and no real competition. We can relax a little and not worry about some of the things we used to when we had less money.” Forde says, “We are very proud of what we have done with no public money, and everyone will get their money back. It is broadband but the whole model is about getting the community to do things for themselves. Where the State cannot deliver and the market cannot deliver, the community is providing.”

Conclusions – Cybermoor/ B4RN

- 38.63 These are just two successful locally initiative community-type broadband projects in remote rural areas in the UK that illustrate the art of the possible. There are others, including projects sponsored by the incumbents.

39. Appendix P: Detailed assessment of planning policy options

39.1 This appendix gives a more detailed assessment of the different planning policy interventions available to the GESP local authorities to incorporate digital connectivity planning policies at the local level. It should be read in conjunction with Section 22.

	Development Plan Documents ('DPDs') – e.g. emerging local plans	SPD	Local Development Order ('LDO')
Requirements	Regulation 5 of The Town and Country Planning (Local Planning) England Regulations states that a document that contains statements including '(iv) development management and site allocation policies, which are intended to guide the determination of applications for planning permission' are to be prepared as local plan documents. As such, any such development management policies pertaining to broadband should be set out in a development plan document (DPD). We would recommend that a DPD policy identifies the following: - the aspirations and/or expectations of the authorities with respect to broadband; - how this will affect development management decisions; - any further or future policy, monitoring or other intentions; and - a justification for such policy.	SPD policies must be sufficiently linked to DPD policies (whether in the GESP or district-level Local Plans), such that they supplement but do not introduce new development management policies. It is recommended that the legal soundness of any SPD is reviewed by legal advisers. The NPPF recommends the use of SPDs 'only... where clearly justified' and where they can help applicants make successful applications or aid infrastructure delivery' (paragraph 153). Further – as per the Town and Country Planning (Local Planning (England) Regulations, 2012 – an SPD must: - provide a reasoned justification for the policies contained in it; - accord and not conflict and accord with the adopted development plan; - be consulted on and incorporate the issues raised in that consultation The Regulations provide considerable flexibility in terms of the content of an SPD. In order for the SPD to be a meaningful and effective, we would recommend that the guidance includes the following (supported by a sufficiently strong and flexible DPD policy): - clear, quantifiable thresholds/development types that are/are not expected to make the provisions; - clarity of the method of contribution, whether this be financial or physical provision and if one can be substituted for the other; and	In order to prepare and adopt an LDO, councils must gather sufficient environmental information to assess the environmental effects of the development that would be consented by the LDO. Like traditional forms of planning consent, LDOs are subject to Environmental Impact Assessment (EIA) where they are considered likely to give rise to significant environmental effects. LDOs can be costly to prepare and time consuming to put in place. But they can also be seen as an upfront investment in realising planning policies and encouraging future development which will bring economic benefits to their area.

		● details on timing, including when is the contribution/provision is expected and how will this be secured.	
Advantages	Digital connectivity policies would have great weight as they would form part of the councils' local development plans once adopted. Both a standalone DPD or SPD would create a single place for all policies relating to digital connectivity across the GE area.	An SPD would be quicker and easier to put into place than either a DPD or putting policies into the local plans because it does not need to go through an examination process. It would therefore be helpful to make direct reference within DPD documents to the role and importance of a further supplementary policy document. For example, this could be statement within an emerging GESP policy (and any emerging local plans) that more detail relating to the specifics and delivery of any broadband infrastructure policy will be brought forward through an SPD. This could help create a strong policy basis for giving weight to an SPD.	The use of LDOs can make development less expensive, less risky and faster for developers as they remove the need to prepare a planning application, pay fees and wait for a decision from the local authority. By creating more planning certainty through consenting development outright, LDOs can make investment in a specific area more attractive to developers. LDOs should be made with a view to what is viable in the local market conditions so that the development they consent is likely to be deliverable and attractive to developers or landowners. Because of the environmental information required, the preparation and adoption of an LDO is likely to be lengthier and more costly than the preparation of an SPD (but less so than a DPD), and does not preclude planning applications for development from coming forward within an area outside of the parameters. LDOs do not replace planning policy, but they could be used in conjunction with the GESP and other local policy documents to help enable the development in broadband 'not spots' or other small areas that would otherwise be appropriate areas for intensification of business or residential development. However, because LDOs do not preclude planning applications for development that exceeds their parameters, putting in place clear and effective broadband policy will remain critical to the delivery of the authorities' broadband authorities.
Disadvantages	It is likely that the inclusion of substantially different or entirely new policies after the Regulation 18 stage of the plans would necessitate a further round of Regulation 18 consultation in order to satisfy the regulations and ensure that the public has been given sufficient opportunity to comment on the councils' policy proposals. An additional round of	An SPD would have less strength than a DPD because it would be 'supplementary' to the development plan.	Paired with the incorporation of planning policies in to the GESP DPD and – potentially – at local DPDs, at more local level, LDOs might provide appropriate mechanisms in which to allow providers or developers to implement broadband-related development a more strategic and joined-up manner, without the need for – or reliance on – individual

	consultation would slow down the local plan process; it could potentially add several months to the programme to adoption for each local plan. Given the evidence presented in this Digital connectivity strategy relating to the economic and social benefits of broadband improvements, the benefits and dis-benefits of this delay should be carefully considered by the councils. However, it is anticipated that adopting the Local Plan would be the priority.		planning permissions. Where an LDO has been successfully adopted, the speedier process might provide providers with more confidence that development will come forward in a manner that incentivises them to develop their networks across the entire area.
Recommendation	For councils that are in the process of developing new local plans it is recommended that policies relating to digital connectivity are included immediately. As part of the plans the policies would be subject to two statutory stages of publication and public consultation ('Regulation 18' and 'Regulation 19' consultation stages), followed by examination in public by the Planning Inspectorate.	A supplementary planning document that sets out the proposals for the whole of the GESP area in one place would send a strong message to developers and other interested parties. It would demonstrate that the councils are united in their vision and that approaches to technical requirements and policy implementation will be consistent across the area. This could help to make implementation as consistent as possible – and therefore make it as easy as possible - for providers and developers whose developments or portfolios of developments will not necessarily align with district authority boundaries. Separate Supplementary Planning Documents The alternative, setting out broadband policies across different policy documents (i.e. in the separate district authorities), might provide less consistency across the GESP authority areas for providers and developers, however this will need to be further considered by the GESP authorities and balanced against the benefits noted above.	It could be helpful to include requirements relating to broadband connectivity within a Local Development Order (LDO) where an LDO is already being developed for a defined area. This might pertain to the necessary conditions with which development permitted by an LDO must comply, or the information that must be submitted when seeking approval of detailed matters from the Local Planning Authority. For example, a requirement might be that schemes must be able to demonstrate that they are capable of delivering up-to-date broadband technology/speeds, or must be able to demonstrate that they are capable of housing multiple ducts to ensure consumer (and provider) competition.

40. Appendix Q: LFFN programme Public Sector Leverage Funding Bid

- 40.1 The process of preparing for such a project in GESP would comprise the following steps:
- Soft market testing – initial discussions with potential alt nets to establish interest, make them aware of the opportunity and to start to explore the scope of a potential ‘deal’
 - Mapping and valuing PSN and publicly owned assets
 - Identifying and embarking on an appropriate procurement process
- 40.2 An immediate opportunity for GESP is to submit full proposals for such a project to the LFFN programme funding call. DCMS issued full guidance notes plus applications forms during December 2017, setting a deadline for round 2 submissions of 26th January 2018 with proposals for subsequent rounds of bidding, with dates to be confirmed.
- 40.3 A key step for GESP if/when it pursues this route will be to undertake an HM Treasury Green Book options appraisal. Below are the features and steps involved

HM Treasury Green Book options appraisal of a PSN/public assets procurement

- The overall objective is to undertake an HMT Green Book compliant options appraisal of a number of alternative, realistic, feasible procurement options in order to identify a ‘preferred option’. The preferred option (possibly with a fall- back option) would then form the basis of a LFFN funding submission.
- The theory-of change underpinning the project, as defined in the briefing information provided by DCMS in support of the LFFN programme, is that bundling of public sector connectivity procurement contracts, along with public sector network and other assets, into a single (or several large) contracts, provides a revenue stream of sufficient scale and reliability that enables telecoms firms to submit bids, that offer more financially advantageous/better services to public sector and, which at the same time, enable bidders to invest in more additional network off footprint,¹⁶⁶ than otherwise would have been the case. The off-footprint network then makes it more cost-effective for the bidder or other telecoms firms to offer ‘full-fibre’ services to SMEs and households in these areas at ‘consumer rather than lease line pricing points’. The larger secure revenue stream is key as it enables bidders to justify bids to their boards and to institutional investors. The LFFN programme does not hide the fact that this approach is based on what Cityfibre has been doing in a number of UK cities¹⁶⁷.
- The purpose of the options appraisal therefore is to ‘model’ (estimate) which ‘procurement option’ is likely to generate the best deal for PSN and the largest off-footprint investment and consequent socio-economic benefits to GE firms and residents. Or in HMT Green Book speak, the preferred option would be the option that is estimated to generate the greatest positive benefit-cost ratio (BCR).
- At the centre of the options appraisal will be a cost-benefit model designed to capture all relevant benefit and cost streams over an agreed appraisal period (we suggest 10,15,20 and 25 years), with all values converted to present values (using the standard NPV function at 3.5% discount rate and possibly a dual rate (to be discussed)).

¹⁶⁶ Off footprint is the telecom’s industry’s term for investment by an existing network owner in additional network coverage outside of/beyond the areas/geographies that their existing network covers. Existing areas that are covered are termed ‘foot print’. Expanding the network beyond existing areas is termed off-footprint

¹⁶⁷ See the appendices to this report for a full list of altnets and their recent investment/ network rollout activities

- The appraisal is essentially a ‘modelling’ exercise of likely outcomes. Actual outcomes will only be known after a real procurement process. The cost benefit model will however be informed by soft market testing to ensure that we model the most likely ‘behaviours of bidders’.
- The cost benefit model and wider appraisal framework can then be used to evaluate bidders’ responses.
- It is essential that the cost-benefit model captures all key benefit and cost streams, the first step therefore is to identify and agree these.
- Reflecting HMT Green Book guidance, the appraisal will model anticipated inputs, activities, outputs, outcomes and impacts; it will convert gross impact to net additional impacts allowing for deadweight, displacement, leakage and appropriate multiplier affects.
- For logistical reasons we suggest that no more than six options are appraised and ideally less, otherwise the comparison process can become overly complex and unwieldy. Reflecting HMT Green Book guidance, the mix of options will include a ‘do nothing/ do minimum’ option as the baseline (counterfactual), then several ‘do-something’ options. The selection of options will draw on examples of what others have done, reflecting:
 - = Extent of aggregation - one single aggregation or a package of aggregations
 - = Scope of aggregation – just PSN or public sector network and other assets
 - = Type of procurement – single contractor, framework or joint venture for example
 - = Type of network architecture
 - = Operational structure
- A risk assessment will need to be undertaken both at option formulation stage and more fully as part of the appraisal, based on sensitivity and scenario modelling. A key risk that will be state aid.
- The cost benefit model will assess the following
 - = **Inputs** – costs of the project – costs will include any LFFN grant that is bid for; an estimated value of any public sector network that is ‘handed-over’ or for which use is allowed; an estimated value of ‘hand-over’ or permitted use of other public sector assets. Any on-going cost streams (or revenue streams forgone) will be capitalised in the final year of the appraisal, in accord with HMT Green Book appraisal guidance
 - = **Outputs** – nature and extent of additional/ improved network serving public sector sites (location, size, nature of site); extent of additional network in the ground, off footprint, serving (or enabling the wider market) to cost-effectively provide services to business parks, residential areas and mixed-use other employment areas. These will need to be ‘monetised’ using a network deployment cost model,
 - = **Outcomes** – resulting additional maximum service level – bandwidth (gigabit-capable etc.; degree of symmetry, other quality of service factors, particularly important to SMEs); degree of open access/competition potential at each level of the value chain and price (estimated pricing points). The additionality needs to be assessed by measuring against the current connectivity baseline, for example using Point Topic data sets and the Adroit Economics connectivity impact mapping and gapping model (see baseline report). The Point Topic data sets identify current consumer broadband services (download, upload and other metrics, by service provider) at post code level. This is then overlain with VOA and ONS data to identify number of business premises (by type) in each post code and associated employment and

GVA. Through this process it is possible to identify post codes that most closely reflect the off-footprint network investment geographies, and run the model for these areas. A similar exercise can be undertaken for any proposed development sites (such as those being put forward by the GEPS) within the off footprint investment areas. The results will show

- number of business premises by type and number of households in off-footprint geographies
- the employment, GVA and number of residents
- baseline - current service availability (download speed and other indicators)
- procurement impact - potential service uplift (download speed uplift) enabled by the off-footprint investment

= **Impacts** – the next step is to model and monetise a package of resulting key socio-economic benefit streams that are likely accrue to households and business in GE. This can be done using pre-existing models, for example:

- **the Adroit Economics SME broadband impact model** - developed as part of our work for the European Commission providing cost benefit and other appraisal tools for regions to use when preparing businesses cases for broadband funding bids. The model can be calibrated by results from a GE SME broadband impact. Metrics include increased productivity, new products and services, increased market reach, wider innovation, increased sales/turnover with key impact measures being net additional jobs and GVA. This will enable modelling of the net additional employment and GVA uplifts that could derive from a given increase in speed/service level availability across a given level of off-footprint investment in LFFN infrastructure
- **the Adroit Economics house broadband impact model** - also developed for the European Commission and calibrated by a recent major study undertaken by Point Topic in the UK. A wide spectrum of benefits is included in the model. This enables us to model the net additional benefits (all benefits are monetised) to households likely to derive from a given increase in speed/service level availability across a given level of off-footprint investment in LFFN infrastructure
- **the Adroit Economics PSN impact model** - developed initially for e-skills UK and then refined for several local authorities, to assist in PSN re-negotiations/ renewal. This model estimates fiscal benefits (cost savings to public sector across a number of functions including health); it also estimates a range of benefits to residents as a result of improved service delivery such as improved educational attainment benefits, online shopping cost savings, and a number of quality of life benefits including time saving

40.4 For each option, these benefit streams will need to be quantified, monetised and mapped over time, discounted (NPV at 3.5% or dual rate). The aggregated net additional benefit figure will be matched against net additional costs to calculate the BCR

40.5 The above is a major and complex exercise. It is possible to undertake the assessment at different levels of granularity, from detailed to a more high level assessment and DCMS may well be prepared to accept high level assessments in support of bids, but even a high level assessment involves collection and collation of PSN contract spend, services, and dates; financial and economic modelling. As a rough guide, we suggest that a two to three month period of time needs to be allowed to complete such an assessment

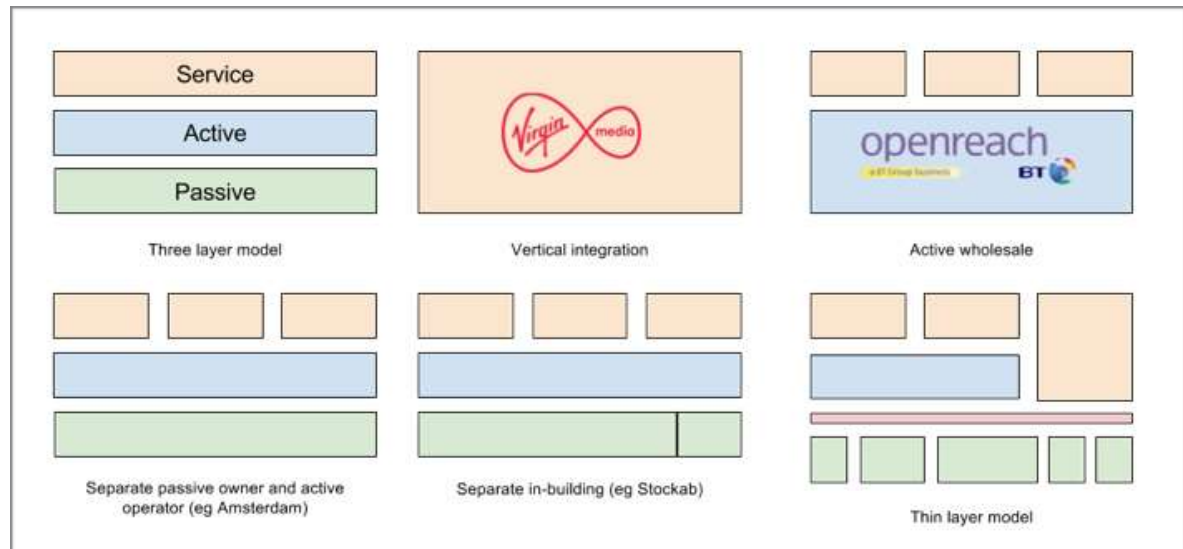
41. Appendix R: Tameside – ‘thin layer’ model

The following text has been provided by the manager of the thin layer model

Tameside – ‘Thin Layer’ model

For further detail, contact Shaun Fesom at Tameside BC

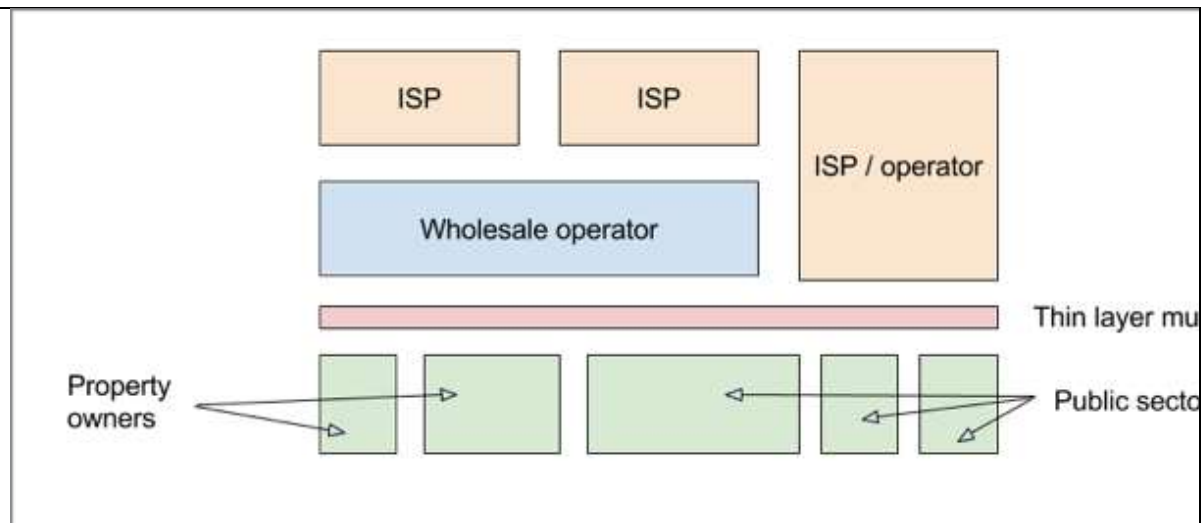
Conventional models have different levels of ‘vertical integration’ between the layers of the infrastructure (see diagram). While there may be competition at the service layer between different ISPs - as in the Openreach model - the lower layers are assumed to belong to a single investor or operator.



This is the assumption in debates about how best to deploy the new fibre that the UK needs:

- Infrastructure monopoly at the lowest layers - for example a state-owned passive network, or shared single fibre provider.
- Infrastructure competition at the lowest layers - where investors ‘overbuild’ each other’s networks.

The Thin Layer Model offers a third way - infrastructure collaboration - using a cooperative model for sharing access to public and private assets.



How this works

- Physical assets (duct) are separately owned, but are sewn together into an integrated 'passive' (dark fibre) network by the 'thin layer' mutual, a cooperative.
- Public sector bodies and private investors can deploy fibre duct for their own use, based on discreet business cases, then make spare capacity available for sharing, in return for a rental fee.
- The cooperative installs and maintains fibre in the duct, and offers it wholesale to public and private sector members.
- The cooperative is not complex - hence the term 'thin layer'. It outsources the maintenance and administrative functions.
- It does not offer services on the open market - only to its members.
- It does not operate any active equipment. It does not offer services like Ethernet or Internet access - this is up to members.
- Anyone can join the cooperative, providing they spend, invest or share above a specified minimum.
- The cooperative is based on the same principles that underline Internet exchanges like LINX - it is guaranteed to stay neutral and serves the mutual interest of members who may be competitors.

This has many benefits

- Investors - including public sector - can invest in 'access' network to reach new buildings as resources allow. Collaboration helps overcome the fixed barriers to investment so that smaller investors and operators can take part. This benefits the local digital-tech sector and economy.
- Investors can focus on market opportunities without (pointless) overbuilding. This saves time and effort.

- Public sector demand can be aggregated over time, and without locking public sector users in to a single aggregator. The thin layer model turns the 'anchor tenancy' model on its head. Rather than rounding up all the public sector users (demand) and going out to procurement (the approach in GMCA and West Sussex), the model creates a core infrastructure. This can then assemble public sector demand, but also effort and assets - over time.
- It will be possible to use the government's Gigabit vouchers to fund new shared infrastructure, so that voucher holders in a building will have a choice of providers - rather than all going with one. This promotes competition and choice. Public money does not benefit a single provider.
- State aid - there is no aid in this model. The public sector is merely acting in the market as it is entitled to. This view has been confirmed in advice commissioned from PwC, from counsel and by the government's own lawyers.

What it means in Tameside:

- The Tameside Digital Infrastructure Cooperative (TDIC) has public sector and private sector members including the council, the hospital, the NHS trust, the main social housing provider and two colleges, together with national and local ISPs and telecoms firms.
- TDIC is run by its members.
- The ducting is mostly owned by the public sector members, although that may change with time.
- Much of the current duct has been installed by Tameside Council recently using the spend that would have gone on a WAN contract renewal, over five years. The hospital and others have installed duct on a similar rationale.
- Ducting alongside the tramway is being used to create a dark fibre route to the IX Manchester Internet exchange.
- Private sector members will invest in new ducting, for example to connect properties to the infrastructure.
- Duct owners are paid a rental fee. The council will collect around £30k per annum from TDIC. The main benefits are elsewhere.
- TDIC will own small amounts of 'access' duct. It offers members an attractive rate of interest on par value shares - around 5% - to attract investment for this purpose.
- TDIC has a limited product set - three types of dark fibre and space in the exchange points. Prices for these products are designed to ensure sustainability while being highly competitive. The biggest market impact is in the open offer of dark fibre - unavailable from Openreach.

42. Appendix S: Assisted/autonomous vehicle connectivity requirements

42.1 The connectivity requirements of assisted/guided vehicles make up a significant component of the total connectivity needs of a new smart settlement. Therefore, its important to provide further explanation of (i) how the connectivity needs have been calculated (ii) the key assumptions and (iii) the degree of certainty.

42.2 This note sets out headline points regarding each.

Context

42.3 Please note though, we have not undertaken a full study of assisted/autonomous vehicle development, time lines, technologies and requirements. This would represent a major study in its own right. Instead, we have only undertaken the very highest level of estimation, based on headline points made in the main stream literature. This is a proportionate level of analysis given that this is primarily a planning-based broadband connectivity study. Furthermore, in-depth research and analysis can be undertaken, if needed, following this assignment, if required.

Assumptions regarding development and adoption of assisted driving

42.4 There is a general consensus that assisted/guided vehicles will be main stream within 5-7 years (i.e. 2023-25)¹⁶⁸.

42.5 There are various levels of ‘assistance\guidance’ suggested. Different authors suggest between 5 to 7 levels of assistance/guidance, from light guidance to full autonomous driving. Indeed, it is arguable that new top end cars, as currently demonstrated by adverts on TV, already include some or many of the elements of level 1 assistance.

42.6 There is no consensus however as to when fully autonomous vehicles may become main stream. Various technologies are being tested, primarily in the US and tests have resulted in a number of unfortunate deaths.

42.7 In our view, it is reasonable to assume that by 2025..ish...a reasonable degree of assistance will be main stream and by 2030/35 we may well see higher levels of assistance moving more towards full autonomous driving (at least as an option) becoming the norm.

42.8 From the perspective of modelling connectivity needs of a smart settlement for GESP purposes, the assessment needs to look ahead to 2035/40, to ensure that digital connectivity infrastructure is built into any new settlement that is capable of supporting the needs of assisted/guided vehicles now, in the short term and in the longer term, by which time it is possible that full automation will be becoming main stream, at least during some portions of the journey

Data requirements of assisted vehicles

42.9 Assisted/autonomous driving will generate/ require a large volume of data – some authors (Google for example), suggest 1Gbps

- Some of these data will derive from transmission between components within the vehicle
- Some will derive from sensors (i.e. transmission and receipt of data by the car’s sensors to the surrounding road, curb, footpath
- Some of these data will derive from vehicle to vehicle transmission

¹⁶⁸ <https://www.computerworld.com/article/2484219/emerging-technology/self-driving-cars-could-create-1gb-of-data-a-second.html>

- Some of these data will derive from communication with surrounding infrastructure
- Some of these data will derive from down and upload of data to the network

The vehicle will send/receive data by a variety of transmission technologies, some of which themselves are not yet fully developed:

- Via sensors
- Via wireless (e.g. WiFi)
- Via the mobile network 4/5G
- Potentially via car-based satellite broadband devices – currently too expensive but under rapid development as we write

Backhaul connectivity requirements, from a new settlement to the main network

At this stage in the development of assisted vehicles, it is uncertain what the precise mix of data transmissions will be and moreover, the precise mix of transmission technologies. Linked to this, it is also unclear what proportion of transmission will be limited to the immediate vicinity as opposed to transmissions to ‘the network’, to the cloud.

Modelling approach adopted

42.10 In light of these considerable uncertainties, we have adopted the following modelling approach:

- We have assumed, for the purposes of GESP timeframes, that all vehicles utilise some form/level of assisted driving – probably with the majority operating at the higher end of the assisted/autonomous spectrum towards the end of the period, generating circa 1Gbps of data
- We have assumed that a notable proportion (perhaps a quarter to a third) of data generated will be sent/received to/from the network and hence will represent a component of backhaul demand for a new settlement
- We have assumed that mobile satellite connectivity remains largely limited to narrow band data (i.e. GSP/SBAS-positioning) and not broadband, because of limited capacity in the satellite network.
- We have therefore assumed that the vast majority transmission to/from the network are via WiFi and that 5G plays the primary role (although precisely how is as yet unknown as 5G is still under development)
- We have therefore modelled a backhaul requirement of 0.4Gbps per vehicle. This is a very approximate assumption.
- This could be plus minus 20/30/40% or more, but either way it’s represents a significant component of backhaul requirement

We have not modelled the connectivity needs of particular stretches of, or types of road

42.11 This is far too micro an analysis, and is not necessary given our objective of estimating overall backhaul needs of a new settlement.

42.12 The requirements of a particular stretch of road or type of road will presumably depend on

- Number of vehicles at peak
- The extent to which/the level at which that particular stretch of road seeks to support assisted/guided driving. It is quite possible that capabilities to support assisted driving will vary

depending on the stretch of road and type of road and that vehicles/drivers will have to have the ability to be flexible in terms of level of driver control

- 42.13 The picture is further complicated by the fact that trunk roads may have their own dedicated backhaul provided say via a dedicated authority, whereas suburban roads will be supported by a separate municipal system, providing a different level of performance specification.