Title: The Electronic Communications (Universal Service)(Broadband) Order 2018
IA No:

RPC Reference No: RPC-4107(2)-DCMS

Lead department or agency: DCMS

Other departments or agencies:

Impact Assessment (IA)

Date: 29/01/2018

Stage: Final

Source of intervention: Domestic

Type of measure: Secondary Legislation

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Summary: Intervention and Options

RPC Opinion: GREEN

Cost of Preferred (or more likely) Option				
Total Net Present Value	**Business Net Present Value**	**Net cost to business per year** (EANDCB in 2014 prices)	**One-In, Three-Out**	**Business Impact Target Status**
£2490.00m	£-477m	£30.5m	In scope	Qualifying provision

What is the problem under consideration? Why is government intervention necessary?

For many, across generations, full participation in society and the economy is impossible without access to the internet. 10Mbps is the minimum download speed that Ofcom says is needed to meet the typical needs of an average family. However, there are still some areas of the UK, particularly, although not exclusively, the more rural areas, which cannot receive speeds of at least 10Mbps as the necessary infrastructure has not been deployed there. There are limits to what the market can deliver through competition alone, and limited commercial incentives for any firm to roll out broadband infrastructure to these areas, given the large investment necessary, and the relatively low returns. Ofcom's Connected Nations 2017 report shows that the number of premises without 10Mbps broadband download and 1Mbps upload speeds is 1.1 million, or 4% of premises, compared with 1.6 million or 6% of premises in 2016**.** Government intervention is necessary on an equity basis to ensure households and small businesses in these areas do not get left behind.

What are the policy objectives and the intended effects?

Policy objectives are designed to reduce the negative social and economic impacts of the digital divide by ensuring universal affordable access to decent broadband. This will help ensure people can fully engage in the digital society, and provide productivity benefits to businesses which use broadband. The preferred option would provide access to download speeds of 10Mbps (with other specified quality requirements) by 2020.

What policy options have been considered, including any alternatives to regulation? Please justify preferred option (further details in Evidence Base)

Regulatory options considered were:

1) 10Mbps connection with no further quality requirements.
2) 10Mbps download and 1Mbps upload with other quality requirements. (Preferred)
3) 20Mbps download and 2Mbps upload with quality requirements.
4) 30Mbps download and 6Mbps upload with quality requirements.

The Government also considered two non-regulatory options: state funding and a non-regulatory proposal from BT, but decided not to pursue these in favour of a regulatory broadband Universal Service Obligation (USO).

The purpose of the regulation is to provide a safety-net in a proportionate manner, in line with the requirements of the EU regulatory framework. This is an intervention targeted at areas of market failure, where the market has not delivered and is not expected to deliver improved connectivity, as the costs of doing so are high, and the returns they can expect to receive, particularly in sparsely populated rural areas, are low. It is intended to ensure that end users do not experience significant social and economic disadvantage compared to end users with access to broadband in competitive markets and that they can participate fully in digital society.

The challenge is to give people a good minimum level of connectivity at affordable prices to allow access to services, such as web browsing, email and certain video services, which meet the needs of a typical family and many small firms. However, setting a minimum level of connectivity has the potential to distort the broadband market, reduce competition, and reduce or divert investment in infrastructure projects, particularly in under-served or rural areas. A further consideration is the impact that this intervention will potentially have on consumer prices, given that it is to be delivered using industry funding, and we can assume that some or all of these costs will be passed on in higher prices. It needs to meet the policy objective while at the same time ensuring that any negative effects on the market are minimised:

- Option 1 - while lower cost, this option does not give people the connectivity they need for common applications, such as video conferencing and sharing large images and video files, which require a specified upload speed, and which are available to the majority.
- Options 3 and 4, give an improved level of connectivity, but come with much higher costs. Higher costs will impose a greater burden on those in industry who will be required to contribute to an industry cost sharing fund - this will be determined by Ofcom in due course, and while Ofcom will be expected to do so in a way that minimises market distortion, some market distortion will arise, and it would be reasonable to assume this distortion would increase with higher costs. These options would also take longer to deliver, which is particularly pertinent given how long households and businesses in USO areas have waited to see connectivity improvement. They would also not be proportionate because these specifications at this time do more than simply provide for 'functional internet access' .

While the BCR is higher for options 3 and 4, the BCR is not the only consideration to be taken into account in designing this policy intervention. This needs to be balanced against the time to deliver the service, and the negative impacts, as noted above, of possible increased market distortion, which may result in reduced competition, reduced market investment and increased consumer prices.

Ofcom has advised that a 10Mbps specification (with quality parameters) is sufficient to meet the needs of a typical household. And while it will be necessary to keep the minimum specification under review, it is not appropriate to set it higher now, even if this does create the potential for efficiency savings in the long term, as this will go beyond Article 4 of the Universal Service Directive which requires that "the connection provided shall be capable of supporting voice, facsimile and data communications at data rates that are sufficient to permit functional Internet access, taking into account prevailing technologies used by the majority of subscribers and technological feasibility."

Therefore, Option 2, which generates a NPV of £2.49bn and a BCR of 3.4 is the preferred option. While Option 2 does not generate the best NPV and BCR, it generates significant benefits, and we believe it strikes a balance between meeting consumer needs for an improved minimum level of connectivity, and minimising market distortion more so than any of the other options. It achieves a balance between ensuring that as many consumers as possible benefit from a good level of connectivity under the USO while at the same time ensuring that the costs of delivery are not disproportionate, and negative impacts on the market are minimised.

Will the policy be reviewed? Yes **If applicable, set review date:** 2028

Does implementation go beyond minimum EU requirements?		No			
Are any of these organisations in scope?	**Micro** Yes	**Small** Yes	**Medium** Yes		**Large** Yes
What is the CO_2 equivalent change in greenhouse gas emissions? (Million tonnes CO_2 equivalent)		**Traded:** N/A		**Non-traded:** N/A	

I have read the Impact Assessment and I am satisfied that, given the available evidence, it represents a reasonable view of the likely costs, benefits and impact of the leading options.

Signed by the responsible : ______________________ Date: ______________________

Summary: Analysis & Evidence Policy Option 1

Description: 10Mbps download with no other specified service specifications

FULL ECONOMIC ASSESSMENT

Price Base Year 2017	PV Base Year 2019	Time Period Years 17	Net Benefit (Present Value (PV)) (£m)		
			Low: 2040	**High:** 2040	**Best Estimate: 2040**

COSTS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant Price)	**Total Cost** (Present Value)
Low	0		55.5	**820.0**
High	0		55.5	**820.0**
Best Estimate	0		55.5	**820.0**

Description and scale of key monetised costs by 'main affected groups'

Key monetised costs are the costs of building the necessary infrastructure to deliver the network required. These costs amount to £0.82 billion (with optimism bias) in present value terms over the appraisal period based on the use of a reasonable cost threshold of £3,400 per premise.

Other key non-monetised costs by 'main affected groups'

BENEFITS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant Price)	**Total Benefit** (Present Value)
Low	0		257.6	**2860.0**
High	0		257.6	**2860.0**
Best Estimate	0		257.6	**2860.0**

Description and scale of key monetised benefits by 'main affected groups'

Key monetised benefits are: £2.86 billion (assuming a reasonable cost threshold of £3,400 per premise) made up of:

1) Local enterprise growth
2) Enterprise productivity growth
3) Increased teleworker productivity
4) Increased participation of carers and the disabled

Other key non-monetised benefits by 'main affected groups'

Key non-monetised benefits are social benefits of equality in better access to information, commercial and public online services, positive wellbeing impacts and community resilience. These benefits are expected to increase over time as services use video conferencing more, such as e-health and e-learning. Those living in physically isolated settings and vulnerable groups such as the elderly stand to benefit the most.

Key assumptions/sensitivities/risks **Discount rate(%)** 3.5%

The key assumption in the benefits modelling is that productivity increases by 0.3% when broadband speeds double. There are also assumptions around the rollout of commercial broadband and therefore the number of eligible premises.

BUSINESS ASSESSMENT (Option 1)

Direct impact on business (Equivalent Annual) £m:			**Score for Business Impact Target (qualifying provisions only) £m: 119.0**
Costs: 52.4	**Benefits:** 28.6	**Net:** -23.8	

Summary: Analysis & Evidence Policy Option 2

Description: 10Mbps download, 1Mbps upload with other service specifications around latency and contention and data cap

FULL ECONOMIC ASSESSMENT

Price Base Year 2017	PV Base Year 2019	Time Period Years 17	Net Benefit (Present Value (PV)) (£m)		
			Low: 2490	**High:** 2490	**Best Estimate:** 2490

COSTS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant Price)	**Total Cost** (Present Value)
Low	0		69.0	**1020.0**
High	0		69.0	**1020.0**
Best Estimate	0		69.0	**1020.0**

Description and scale of key monetised costs by 'main affected groups'

Key monetised costs are the costs of building the necessary infrastructure to deliver the network required. These costs amount to £1.02 billion (with optimism bias) in present value terms over the appraisal period based on the use of a reasonable cost threshold of £3,400 per premise.

Other key non-monetised costs by 'main affected groups'

BENEFITS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant Price)	**Total Benefit** (Present Value)
Low	0		317.2	**3510.0**
High	0		317.2	**3510.0**
Best Estimate	0		317.2	**3510.0**

Description and scale of key monetised benefits by 'main affected groups'

Key monetised benefits are: £3.51 billion (assuming a reasonable cost threshold of £3,400 per premise) made up of:

1) Local enterprise growth
2) Enterprise productivity growth
3) Increased teleworker productivity
4) Increased participation of carers and the disabled

Other key non-monetised benefits by 'main affected groups'

Key non-monetised benefits are social benefits of equality in access to better information, commercial and public services, positive wellbeing impacts and community resilience. These benefits are expected to increase over time as more services use video conferencing, such as e-health and e-learning. Those living in physically isolated settings and vulnerable groups such as the elderly stand to benefit the most.

Key assumptions/sensitivities/risks	**Discount rate(%)**	3.5%
The key assumption in the benefits modelling is that productivity increases by 0.3% when broadband speeds double. There are also assumptions around the rollout of commercial broadband and therefore the number of eligible premises.		

BUSINESS ASSESSMENT (Option 2)

Direct impact on business (Equivalent Annual) £m:			**Score for Business Impact Target (qualifying provisions only) £m: 152.5**
Costs: 65.2	**Benefits:** 34.7	**Net:** -30.5	

Summary: Analysis & Evidence Policy Option 3

Description: 20Mbps download, 2Mbps upload with other service specifications around latency and contention and data cap

FULL ECONOMIC ASSESSMENT

Price Base Year 2017	PV Base Year 2019	Time Period Years 17	Net Benefit (Present Value (PV)) (£m)		
			Low: 3680	**High:** 3680	**Best Estimate:** 3680

COSTS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low	0		96.1	**1420.0**
High	0		96.1	**1420.0**
Best Estimate	0		96.1	**1420.0**

Description and scale of key monetised costs by 'main affected groups'

Key monetised costs are the costs of building the necessary infrastructure to deliver the network required. These costs amount to £1.42 billion (with optimism bias) in present value terms over the appraisal period based on the use of a reasonable cost threshold of £3,400 per premise.

Other key non-monetised costs by 'main affected groups'

BENEFITS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Benefit (Present Value)
Low	0		460.6	**5100.0**
High	0		460.6	**5100.0**
Best Estimate	0		460.6	**5100.0**

Description and scale of key monetised benefits by 'main affected groups'

Key monetised benefits are: £5.10 billion (assuming a reasonable cost threshold of £3,400 per premise) made up of:

1) Local enterprise growth
2) Enterprise productivity growth
3) Increased teleworker productivity
4) Increased participation of carers and the disabled

Other key non-monetised benefits by 'main affected groups'

Key non-monetised benefits are social benefits of equality in better access to information, commercial and public online services, positive wellbeing impacts and community resilience. These benefits are expected to increase over time as services use video conferencing more, such as e-health and e-learning. Those living in physically isolated settings and vulnerable groups such as the elderly stand to benefit the most.

Key assumptions/sensitivities/risks — **Discount rate(%)** 3.5%

The key assumption in the benefits modelling is that productivity increases by 0.3% when broadband speeds double. There are also assumptions around the rollout of commercial broadband and therefore the number of eligible premises.

BUSINESS ASSESSMENT (Option 3)

Direct impact on business (Equivalent Annual) £m:			Score for Business Impact Target (qualifying provisions only) £m: 187.5
Costs: 90.8	**Benefits:** 53.3	**Net:** -37.5	

Summary: Analysis & Evidence Policy Option 4

Description: Superfast 30Mbps download, 6Mbps upload with quality specifications for latency and contention

FULL ECONOMIC ASSESSMENT

Price Base Year 2017	**PV Base Year** 2019	**Time Period Years** 17	**Net Benefit (Present Value (PV)) (£m)**		
			Low: 3880	**High:** 3880	**Best Estimate:** 3880

COSTS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant Price)	**Total Cost** (Present Value)
Low	0		110.3	**1630.0**
High	0		110.3	**1630.0**
Best Estimate	0		110.3	**1630.0**

Description and scale of key monetised costs by 'main affected groups'

Key monetised costs are the costs of building the necessary infrastructure to deliver the network required. These costs amount to £1.63 billion (with optimism bias) in present value terms over the appraisal period based on the use of a reasonable cost threshold of £3,400 per premise.

Other key non-monetised costs by 'main affected groups'

BENEFITS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant Price)	**Total Benefit** (Present Value)
Low	0		496.6	**5510.0**
High	0		496.6	**5510.0**
Best Estimate	0		496.6	**5510.0**

Description and scale of key monetised benefits by 'main affected groups'

Key monetised benefits are: £5.51 billion (with a reasonable cost threshold of £3,400 per premise) made up of:

1) Local enterprise growth
2) Enterprise productivity growth
3) Increased teleworker productivity
4) Increased participation of carers and the disabled

Other key non-monetised benefits by 'main affected groups'

Key non-monetised benefits are social benefits of equality in access to better information, access to commercial and public online services, positive wellbeing impacts and community resilience. These benefits are expected to increase over time as services use video conferencing more, such as e-health and e-learning.Those living in physically isolated settings and vulnerable groups such as the elderly stand to benefit the most.

Key assumptions/sensitivities/risks — **Discount rate(%)** 3.5%

The key assumption in the benefits modelling is that productivity increases by 0.3% when broadband speeds double. There are also assumptions around the rollout of commercial broadband and therefore the number of eligible premises.

BUSINESS ASSESSMENT (Option 4)

Direct impact on business (Equivalent Annual) £m:			**Score for Business Impact Target (qualifying provisions only) £m: 233**
Costs: 104.2	**Benefits:** 57.6	**Net:** -46.6	

Evidence Base

Summary

In an increasingly digital world, people need to get online no matter where they live or work. A high speed internet connection has become a necessity, rather than a nice-to-have, enabling access to a wealth of online services and information such as news, TV, e-commerce, online banking, and public services. Broadband is now widely seen as an essential service, much like electricity and water. According to data from the Office for National Statistics' 2017 Opinions and Lifestyle Survey, the internet is accessed every day, or almost every day, by 80% of adults in the UK, compared with 35% in 2006.[1]

For many, across generations, full participation in society is impossible without access to the internet. A recent literature review found a number of articles citing a longer-term concern that the withdrawal of commercial and public organisations from physical locations to being solely available online will be damaging to non-users of the internet, with the suggestion that an inability to access online services may "generate a new dimension of social exclusion that transcends conventional 'causes' of disadvantage such as low income"[2]. Access to a high speed internet connection is especially important as a means of ensuring that people in rural areas can enjoy access to the services and information that are available in many urban areas - 17% of premises in rural areas do not have a broadband connection with 10Mbps download and 1Mbps upload speeds compared to 2% in urban areas[3]. For business, reliable and consistent connectivity can boost productivity and make it possible to build new business contacts around the world, reduce travel, and save money.

Although the market has met this demand for connectivity for the majority, there are areas where Government intervention has been required to extend this further. Since 2010, £1.7 billion of public funding is being invested in improving broadband, of which more than £790 million is from central Government, to bring superfast broadband (24Mbps and above[4]) to areas of the UK where the commercial case for investment is more challenging. Superfast broadband is now available to over 95% of UK homes and businesses – up from 45% in 2010[5]. However, even with this investment and commercial roll-out, there are many that do not yet have high speed broadband connectivity.

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1 https://www.ons.gov.uk/peoplepopulationandcommunity/householdcharacteristics/homeinternetandsocialmediausage/bulletins/internetaccesshouseholdsandindividuals/2017

2 Philip, L., C. Cottrill, J Farrington, F. Williams & F Ashmore (2017): "The Digital Divide: Patterns, policy and scenarios for connecting the 'final few' in rural communities across Great Britain" in Journal of Rural Studies, 2017 pp1-13. https://www.sciencedirect.com/science/article/pii/S0743016716306799

3 https://www.ofcom.org.uk/research-and-data/multi-sector-research/infrastructure-research/connected-nations-2017/main-report Figure 13, page 24

4 Government defines superfast broadband as speeds greater than 24Mbps, whereas Ofcom and the EU defines it as speeds greater than 30Mbps

5 https://www.gov.uk/government/news/superfast-broadband-now-available-to-more-than-19-out-of-20-uk-homes-and-businesses

To ensure that these remaining premises do not get left behind, in November 2015 the then Prime Minister announced the UK Government's intention to introduce a broadband Universal Service Obligation (USO), with the ambition of giving people the legal right to request a connection to broadband with speeds of 10Mbps no matter where they live or work.[6] This commitment was confirmed by the creation of enabling powers in the Digital Economy Act 2017, which allow for a new broadband USO of at least 10Mbps to be introduced.

The Digital Economy Act 2017 also sets out two mechanisms which enable the Government to initiate a review of the USO to ensure that it keeps pace with consumers evolving needs:[7]

- A discretionary power that allows the Secretary of State to direct Ofcom to review the USO at any time (after consulting with Ofcom)
- A requirement that the USO be reviewed when the uptake of superfast broadband (30Mbps or more) reaches at least 75% of UK premises.

Any review, would look not just at whether the minimum download speed needs to be changed, but also any other of the USO quality parameters.

This impact assessment follows a public consultation on the design of the broadband USO[8] and accompanies the secondary legislation setting the scope of the USO, which Ofcom will be responsible for implementing.

1. Background

1.1 Consumer needs

Advances in technology, and people's responses to these, mean that the way we use the internet has changed considerably. The average internet user has progressed from using the internet for web browsing and emailing, to using it to access a vast range of far more complex information and services such as video streaming and calling.

In addition to download speed, the consumer experience, and what can be done with a broadband connection, is affected by a number of other factors - upload speed, latency, contention ratio and capacity.

- Upload speed - while most consumer internet usage today relies mostly on downloading content such as web-browsing, email and standard video streaming, some other common applications, such as video conferencing and sharing large images and video files (which may be particularly useful for SMEs) can require a specified upload speed.
- Latency - the round trip delay in the transmission of data - can in particular affect the performance of live applications, such as live video streaming, gaming and video calling/conferencing.

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[6] https://www.gov.uk/government/news/government-plans-to-make-sure-no-one-is-left-behind-on-broadband-access

[7] Digital Economy Act 2017 s1(7) amends the Communications Act 2003 to add s72A and s72B as provisions to review the USO.

[8] https://www.gov.uk/government/consultations/broadband-universal-service-obligation-consultation-on-design

- Contention - the degree to which bandwidth is shared between different end users - will affect the speed that consumers experience at busy times.
- Data capacity - communications providers use data caps to manage the amount of data consumers use. This is particularly an issue where network capacity is constrained, and providers often charge more for higher data caps.

In just one year, from 2016 to 2017, the average monthly data usage per fixed broadband residential connection increased from 132 gigabytes of data to 190 gigabytes of data.[9] According to the Intellectual Property Office (IPO), 62% of UK internet users downloaded or streamed music, TV shows, films, computer software, video games or e-books over the three-month period March-May 2015[10], while an Ofcom survey from 2015 shows that almost six in ten adults used at least one type of video on demand service.[11] While emailing and basic web browsing requires an internet connection with relatively low download speeds (<1Mbps), high-definition (HD) video streaming and other data heavy services, such as video conferencing, require higher download speeds of between 6-8Mbps. Higher quality video streaming such as ultra HD or 4K would however require higher data rates.[12]

Furthermore, households are increasingly using multiple internet devices at the same time. According to Ofcom's 2015 Communications Market Report, on average, households in the UK own four different types of internet-enabled device, with almost seven in ten (69%) having three or more.[13] These trends show that the speed required by the average household, to access more data heavy services on more devices, is increasing.

In its 2015 Connected Nations report, Ofcom set out how an average household requires download speeds of at least 10Mbps, with multiple occupants simultaneously live streaming television, accessing media through VoD channels, using video calling and basic web browsing. A minimum high speed, affordable connection will make sure nobody is digitally excluded and that small businesses are equipped with the tools they need to compete. Individuals will be able to access a range of services and information online; families will find it easier to keep in touch; children will benefit from access to tools to support their homework and learning; businesses can get online, compete and grow; people in rural areas will be able to access services, to work, shop, and communicate without the need for travel. Ofcom also found that connections below 10Mbps use less data, possibly constrained by speed on that line. The average amount of data used increases rapidly in line with the available download speed on the line – up to around 10Mbps. After this point, the correlation between data use and download speed is far less pronounced. In its 2017 Connected Nations report it reconfirmed that 10Mbps continues to be a reasonable threshold for a

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9 https://www.ofcom.org.uk/__data/assets/pdf_file/0024/108843/summary-report-connected-nations-2017.pdf, dashboard

10 https://www.gov.uk/government/news/uk-consumers-give-boost-to-legal-downloading-and-streaming-for-tv-films-and-music

11 https://www.ofcom.org.uk/__data/assets/pdf_file/0024/26826/cmr_uk_2016.pdf

12 https://www.ofcom.org.uk/__data/assets/pdf_file/0022/108517/connected-nations-evolution-television-2017.pdf, para 9.17

13 https://www.ofcom.org.uk/__data/assets/pdf_file/0022/20668/cmr_uk_2015.pdf page 344

decent broadband download speed, with people's internet use being constrained at lower download speeds[14].

Ofcom's view is that a 10Mbps download speed is sufficient for now but may need to evolve over time.[15] [16] A report by the Federation of Small Businesses shared this assessment, recommending minimum speeds of 10Mbps for all business premises in the UK.[17] According to Ofcom estimates 230,000 SMEs (7% of SMEs) do not have access to decent broadband.[18] Furthermore, a British Chamber of Commerce survey in March 2017 found that 99% of all companies thought a reliable broadband connection was important, with 82% saying it was "extremely so".[19] The Government has established a Business Connectivity Forum, involving business representatives, telecoms providers and other relevant organisations, to examine the issues businesses face in getting appropriate connectivity and make recommendations.

Examples of the services which might be simultaneously used with a 10Mbps connection

Web browsing	Yes
Video calling	Yes
Streaming music	Yes
Downloading an album	1-2 mins
Streaming an HD movie	Yes
Downloading an HD movie	1-1.5 hrs

1.2 The wider benefits of universal access to higher speed broadband internet

There are clear benefits to be accrued from improving the reliability and ubiquity of broadband in the UK with speeds that, at the very least, meet consumer and small business demands for download speeds of 10Mbps. Society also benefits from the reduction of the digital divide, by improving access to the digital economy, such as e-commerce, and digital public services. Economic benefits derive from improved productivity and efficiency of firms, and from the increased access to the job market for individuals. Businesses in rural areas make a substantial contribution to the national economy: predominantly rural areas contributed 16.4% of England's GVA, worth an

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14 https://www.ofcom.org.uk/__data/assets/pdf_file/0016/108511/connected-nations-2017.pdf, see figure 20 on page 31

15 https://www.ofcom.org.uk/__data/assets/pdf_file/0028/95581/final-report.pdf, page 12

16 http://stakeholders.ofcom.org.uk/binaries/research/infrastructure/2015/downloads/connected_nations2015.pdf

17 http://www.fsb.org.uk/media-centre/press-releases/the-uks-broadband-isnt-up-to-speed-says-fsb-pr-2014-30

18 https://www.ofcom.org.uk/__data/assets/pdf_file/0016/108511/connected-nations-2017.pdf, page 24

19 http://www.britishchambers.org.uk/policy-maker/policy-reports-and-publications/bcc-digital-survey-2017-broadband.html

estimated £246 billion in 2016[20]. Approximately 24% of all registered businesses are located in rural areas, accounting for 13% of all those employed[21]. In addition, if more people can access reliable high speed internet, more complex public services can be delivered directly to individuals than under the current non-statutory 2Mbps minimum. There are also wider benefits to society, such as the environmental benefits of increased remote working (from reduced travel pollution). These benefits are discussed in more detail later in this document (section 7), and are quantified - as far as is possible - in the options appraisal.

1.3 The Universal Service Obligation

The objective of the broadband USO is to reduce the negative social and economic impacts of the digital divide by ensuring universal affordable access to decent broadband. This will help ensure people can fully engage in the digital society, and provide productivity benefits to businesses which use broadband. This intervention is targeted at areas of market failure, where the market has not delivered and is not expected to deliver improved connectivity, to provide a safety net for homes and small businesses in the hardest to reach parts of the UK, which will ensure that no one is left behind.

The EU Framework Directive[22], and Universal Service Directive adopted in 2002,[23] and revised in 2009,[24] provide the framework within which the broadband USO operates.

- Under the 2002 Directive, Member States are required to ensure that all reasonable requests by end-users for connection at a fixed location are met. The connection must support voice and data communications permitting 'functional internet access' - in 2002, the Directive restricted the definition of functional internet access to narrowband or 'dial up' rates achievable over a narrow band (telephone) line. All Member States were required to fulfil this requirement , and the UK decided to introduce its telephony USO in 2003 to meet it. The telephony USO continues to exist today, with BT and KCOM being the designated universal service providers.
- However, since the Directive was introduced, the concept of functional internet access has changed as technology and consumer demands have evolved - narrowband connections rapidly became inadequate to support consumers online needs. In light of this, the 2009 revisions to the Directive gave Member States flexibility to choose whether to also include broadband connectivity as part of universal service, according to their own national circumstances. The 2009 revisions gave Member States the option to introduce a broadband USO with minimum speeds if they determined national conditions make it necessary to do so. In determining this, Member States were required to - take into

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20 https://www.gov.uk/government/statistics/rural-productivity

21 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/641459/Businesses_August_2017_Digest.pdf

22 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32002L0021&from=EN

23 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32002L0022&from=EN

24 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:337:0011:0036:en:PDF

account the prevailing bandwidth used by the majority of subscribers and technological feasibility[25].

The Directive provides for a USO to be funded via a cost-sharing mechanism financed by communications network and service providers, or by public funding, or a combination of the two.

The EU Framework Directive requires technology neutrality - which means that we cannot explicitly specify the technologies used to deliver the USO . A requirement of the US Directive is, however, that the USO should be implemented in the most efficient way. This means USPs tend to be the operators with the most extensive networks, or whose networks can be extended to comply with the USO at least cost.

The Communications Act 2003 transposed the Directive into domestic legislation, and delegated a number of functions for implementation of the USO to Ofcom, the UK's independent national regulator for the communications industries. Under this framework, in 2003, Ofcom designated British Telecommunications plc and Kingston Communications (Hull) plc (now KCOM) as USPs to provide telephony services, including functional internet access, which was defined in guidelines at the time as a connection with narrowband download speeds of at least 28.8 Kbps.[26] In December 2015, the Government introduced a non-statutory scheme - the Better Broadband Scheme - offering a subsidised broadband connection to homes and businesses unable to access speeds of at least 2Mbps. This scheme was due to finish at the end of December 2017, but was recently extended to December 2018.

Given the increasing take-up and usage of ever faster broadband speeds across the UK, the Government is introducing a broadband USO with a new threshold for 'functional internet access', to ensure that people can engage fully in digital society by ensuring universal affordable access to decent broadband, in line with the requirements of option 2.

Ofcom advises that download speeds of at least 10Mbps, along with other quality parameters to ensure a good user experience, is the minimum level of broadband performance required for internet access to services such as web browsing, email and certain video services, which meets the needs of a typical family and many small firms. Ofcom has also found that connections below 10Mbps use less data, possibly constrained by speed on that line. A 10Mbps connection has therefore been the starting point for our considerations of options for design of the USO. It establishes a safety-net for universal access to broadband that can be increased over time as requirements change. A minimum download speed of 10Mbps has been included in the enabling powers in the Digital Economy Act 2017.

[25] http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32009L0136&from=EN Citizens' Rights Directive Recital 5

[26] http://www.ofcom.org.uk/static/archive/oftel/publications/eu_directives/2003/uso0703.pdf

2. The Broadband Market and Contextual Government Intervention

2.1 State of the broadband market

Fixed broadband services in the UK are provided largely over two networks: the Openreach network and Virgin Media's cable network. Both are looking to extend their coverage between now and 2020.

The Openreach network extends across almost all of the UK except in Hull, where telephony and local access services are provided by KCOM. Openreach mainly uses Fibre to the Cabinet (FTTC)[27], and some Fibre to the Premise (FTTP)[28] to provide superfast services. Communications providers such as BT, Sky and TalkTalk offer superfast broadband services of 24Mbps+ over the Openreach network. Standard broadband services below 24Mbps are also available, using a connection that is entirely copper from the exchange to the consumer's premises. Openreach has also committed to delivering ultrafast speeds (100Mbps+) using FTTP and G.fast[29] to 12 million homes and businesses by the end of 2020, 770,000 of which have been passed to date[30].

Virgin Media, the second largest broadband operator, has announced plans to expand its network to cover 17 million premises (60% of the UK) by 2019[31]. Virgin has more of a presence in urban areas than in rural areas, and offers an ultrafast cable service of up to 300 Mbps for residential customers across its network.

There are also a growing number of smaller providers such as CityFibre, Hyperoptic and Gigaclear, who are building fibre networks and increasing the choices available to households and businesses, in urban and rural areas. There are also alternatives to fixed broadband for customers seeking high speed broadband, including fixed wireless, satellite and 4G mobile. A full description of these technologies and an assessment of each market is set out in the technology annex attached to this document.

There are, however, still some areas of the UK, particularly, though not exclusively, the more rural areas[32], which cannot receive download speeds of 10Mbps and 1Mbps upload, as the necessary infrastructure has not been deployed there. There are limited commercial incentives for any firm to roll out broadband infrastructure to these areas, given the large investment necessary, and the relatively low returns.

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[27] FTTC is the technology used to support most superfast lines, where the copper cable between the local exchange and the street cabinet is replaced with optical fibre, but the final connection to the consumer's home or business is still made of copper, using Very-high-bit-rate Digital Subscriber Line (VDSL) and, to a limited extent, G.Fast technologies. See the technology annex for further detail.

[28] This extends the fibre network to the customer premises and is capable of delivering very high speeds, well in excess of 300Mbps.

[29] G.fast is capable of providing download speeds up to 330Mbps (and potentially beyond) over Openreach's existing copper-based network

[30] http://www.btplc.com/Sharesandperformance/Quarterlyresults/2017-2018/Q2/Downloads/Newsrelease/q217-release.pdf

[31] http://www.virginmedia.com/corporate/media-centre/press-releases/virgin-media-announces-largest-uk-fibre-broadband-rollout.html

[32] https://www.ofcom.org.uk/research-and-data/multi-sector-research/infrastructure-research/connected-nations-2017

2.2 Contextual Government Intervention

The market has been successful in delivering broadband to much of the UK, but without some public intervention many areas would have been left behind. To date, the Government has intervened in the following ways:

Superfast Broadband Programme
£1.7bn of public funds is being invested to support the rollout of superfast broadband in the UK through Broadband Delivery UK (BDUK), to ensure that at least 95% of the UK had access to superfast broadband at the end of 2017. BDUK estimates that efficiency savings, coupled with clawback and further commercial roll-out, could extend superfast broadband coverage to at least 97% of UK homes and businesses by 2020. More information on BDUK's programmes can be found on their website.[33]

Local Full Fibre Networks Programme
BDUK are also delivering the Local Full Fibre Networks Programme (LFFN), which aims to stimulate commercial investment in full fibre networks in locations across the UK, including rural and urban locations in England, Scotland, Wales and Northern Ireland, by demonstrating approaches that encourage additional private investment and by making sustainable commercial deployments viable. Support has been made available through a Challenge Fund[34] - a Government capital grant programme of up to £190m. To bid successfully, local bodies will need to demonstrate they can harness public sector connectivity and aggregate private sector demand, to stimulate the market to build new and extend existing fibre networks in their areas.

Universal Service Commitment
In order to provide for those premises that have not been reached by commercial rollout or BDUK's Superfast Broadband Programme, the Government committed to ensuring the availability of an internet connection with download speeds of at least 2Mbps for every UK household and business through its Universal Service Commitment (USC). This is being delivered through the BDUK Better Broadband Subsidy Scheme which provides a subsidised broadband installation to homes and businesses that are unable to access a broadband service with a download speed of at least 2Mbps and who will not benefit from the superfast broadband roll out [35].

Devolved Administration investment
Additional public funding is to be made available to extend superfast broadband roll out in the Devolved Administrations. The Scottish Government has announced an initial £600m investment to deliver universal superfast broadband coverage by 2021 (including Scotland's Phase 2 funding from the Superfast Broadband Programme and utilising underspends and clawback funding), and launched a procurement process on 18 December 2017 with rollout expected to begin by early

[33] https://www.gov.uk/guidance/broadband-delivery-uk
[34] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/661364/Challenge_Fund.pdf
[35] https://basicbroadbandchecker.culture.gov.uk/

2019[36]. The Welsh Government has announced that up to £80m would be available for additional superfast roll out by 2020, starting in Spring 2018 (again, including funding from the Superfast Broadband Programme). In Northern Ireland, £150m has been allocated for broadband infrastructure as part of the June 2017 funding agreement between the Democratic Unionist Party (DUP) and the Conservative party, though it is as yet to be determined how this will be invested.

3. Problem under consideration and rationale for intervention

Commercial roll-out of broadband and BDUK's Superfast Broadband Programme was successful in ensuring access to superfast broadband for 95% of the UK (27.3 million premises) by the end of 2017. Efficiency savings, coupled with clawback from the BDUK programme, along with new superfast procurements in Scotland, Wales and Northern Ireland and further procurements in England (including a minimum £30m of available funding from Defra from the Rural Development Programme for England) are expected to extend superfast broadband to at least 97% of UK premises by 2020. In addition, the Local Full Fibre Networks (LFFN) programme, aimed at supporting local bodies to accelerate the roll out full fibre infrastructure across the UK and stimulate commercial investment, will deliver connectivity capable of extremely high speeds (100Mbps+). The approaches that the LFFN programme will support are not however specifically targeted at locations with low or no connectivity, as it is up to local bodies to determine what specific areas their projects will include, and may lead to infrastructure upgrades in areas which already benefit from superfast broadband, rather than extending coverage and further reducing the size of the USO footprint. However, as the LFFN programme investment will lead to more extensive fibre deployment, it is expected that it could potentially reduce the cost of providing backhaul to connect premises in the USO footprint, and will enable more premises to be connected below the USO cost threshold.

Despite these investments there will still be a significant number of premises which will not be able to access 10Mbps download and 1Mbps upload speeds.

Scope

A key part of this analysis is the scope of the policy and the counterfactual of what will happen to broadband coverage while the USO is being developed and implemented. This is most clearly represented by the number of premises that will not have access to a connection which meets the specified technical requirements when the USO is implemented. Ofcom's December 2016 technical advice to Government *Achieving decent broadband connectivity for everyone*[37] provided estimates for the number of eligible premises in scope for different options at different periods in time, as set out in the table below. These ranged from around 300,000 premises for the lowest specification USO in the early 2020s, to 3.5 million premises for the highest specification USO in 2016. The volume of premises in scope falls over time as planned and expected commercial and publicly funded investments reduce the size of the potential USO footprint.

[36] http://www.gov.scot/Publications/2017/12/2810/1
[37] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/95581/final-report.pdf

However, these figures were forecasts only, and are based on a number of assumptions, and the further into the future that the projection is provided for, the greater the level of uncertainty. For example, if deployment of superfast takes place in different locations than planned, then the number of eligible premises could change. Of the premises that are to be connected to superfast, it is possible that some will be in the areas without access to 10Mbps, thus reducing this figure and the scope of the USO. However, it is likely that further superfast rollout, should it follow the trend of previous rollout, will target those areas that are easiest to reach next, and can be reached more cost effectively, which are more likely to be areas above 10Mbps but below superfast. There is more discussion of this under the 'do nothing' option. It is also worth noting that Ofcom's projections for coverage in the "early 2020s" also do not fully align with the expected implementation timetable of the USO, which is expected to have been implemented by early 2020 rather than the early 2020s.

Ofcom provided updated technical advice[38] in July 2017 which included an estimate of premises in scope for an additional 20Mbps option requested by DCMS (Option 3 in the table below), based on 2016 data.

In December 2017, Ofcom published, as part of their Connected Nations 2017 report, updated estimates for the number of premises in scope of options 1 & 2 options based on data provided by broadband providers in May 2017[39]. Their estimate of the number of premises in scope of Option 2 reduced from 2.6m to 1.6m further demonstrating the uncertainties in measuring and estimating the premises in scope. Ofcom have also subsequently provided updated estimates for options 3 & 4 based on the same data. We have used these estimates for the purposes of the updated cost benefit analysis in this impact assessment. However, it is important to note that these figures may be an overestimate of the size of the USO footprint - and therefore the total costs and benefits of implementation - as by the time the USO is in place, around 2 years from now, this figure could have further reduced to some extent due to further commercial and public deployment. However, given the uncertainties over the extent of future investment, it is not possible to say with any degree of certainty the extent to which the scope may change.

Although there have been significant reductions in premises in scope in recent years (in particular between 2016 and 2017) these were largely driven by public subsidy for superfast rollout, and as this programme begins to enter its final phase it is unlikely to impact greatly on the hardest to reach areas within scope of this policy – it will reach 97% of UK premises, leaving around 3% unserved by superfast.

Connectivity to the last 3% of properties following the Superfast Broadband Programme is likely to remain commercially unattractive. Even the 95% coverage achieved through the Superfast Broadband Programme required significant Government investment (£1.7bn) to tip them into being commercially viable. In fact many of the premises in this Universal Service Obligation (USO) footprint were out of scope for the Superfast Broadband Programme precisely because of the high costs involved in reaching them.

[38] https://www.ofcom.org.uk/__data/assets/pdf_file/0015/105342/Technical-advice-on-a-broadband-USO-Updated-cost-estimates.pdf

[39] https://www.ofcom.org.uk/__data/assets/pdf_file/0016/108511/connected-nations-2017.pdf, figure 12 page 23

These costs will remain exceptionally high because the distance from existing exchanges to individual properties means that incumbent copper network infrastructure cannot be leveraged to connect them with acceptable speed/reliability. Therefore other technology solutions are required, for example new fibre build or new fixed wireless access infrastructure. The capital cost of this new infrastructure, relative to the revenues possible from sparsely populated areas, does not make for a strong commercial case for network operators. This in turn has resulted in a market failure - hence why are implementing the USO. Through industry consultation we have verified that this investment case is not expected to change for these areas.

We consider the 2017 figures for the premises in scope are the most sensible basis for the analysis at this point in time as:

- forecasting is highly speculative given the number of factors involved,
- there is uncertainty in the underlying data, as demonstrated by the change in premises in scope of option 2 in 2016 reported in the 2017 Connected Nations report
- as the Superfast Broadband Programme enters its final phase it is unlikely to impact greatly on the hardest to reach areas
- Ofcom's forecasts have not been updated with the 2017 data or the latest progress of the Superfast Broadband Programme
- the commercial case will remain weak for the premises in a USO footprint given the high capital cost of new infrastructure, relative to the revenues possible from sparsely populated areas.

In addition, sensitivity analysis carried out on the cost modelling show that the costs are not that sensitive to the number of premises in scope. For example, under option 2 a difference between using the 2017 figures, and assuming 30% of premises would be covered by commercial operators resulted in a difference in costs of £1.27bn to £1.1bn Using Ofcom's previous forecasts would estimate this cost at £1.01bn. This is not a sufficiently large change to alter the overall conclusions from the cost benefit analysis. See section 6.5 for more details.

Table 1 - Premises in Scope of Options as estimated by Ofcom (various sources as set out below table)

	Option 1 **10Mbps download only**	**Option 2** **10Mbps download; 1 Mbps upload; latency (medium response time); contention ratio of 50:1;**	**Option 3** **20Mbps download; 2Mbps upload; latency (medium response time); contention ratio of 50:1;**	**Option 4** **30Mbps download; 6Mbps upload; latency (fast response time); a 'committed information rate';**

		data cap of 100GB per month	Data cap of 100GB per month	unlimited usage cap.
2016	**1.4m[ab]**	**1.6m*[c]**	**3.0m[b]**	**3.5m[ab]**
2017	**0.9m[c]**	**1.1m[c]**	**2.2m[d]**	**2.7m[d]**
2020s	**~0.3m[ab]**	**~0.6m[ab]**	**~0.9m[b]**	**~1.1m[ab]**

***In Ofcom's technical advice and the consultation this was estimated at 2.6m. Ofcom have revised this figure down in Connected Nations 2017.**

Sources:
a - Ofcom, Achieving decent broadband connectivity for everyone, December 2016, https://www.ofcom.org.uk/__data/assets/pdf_file/0028/95581/final-report.pdf
b - Ofcom, Technical advice on a broadband USO: Updated cost estimates, July 2017, https://www.ofcom.org.uk/__data/assets/pdf_file/0015/105342/Technical-advice-on-a-broadband-USO-Updated-cost-estimates.pdf
c -Ofcom, Connected Nations 2017, December 2017, https://www.ofcom.org.uk/__data/assets/pdf_file/0024/108843/summary-report-connected-nations-2017.pdf
d - Ofcom, data request for DCMS (unpublished, based on Connected Nations 2017 data), December 2017

Rural communities are disproportionately affected by this lack of access, given their remoteness and low population densities, and the consequently high cost of delivering broadband to them. These same factors also mean that the benefits are higher to these communities through greater reductions in travel, increased access to services and reduced isolation. Ofcom's Connected Nations 2017 report estimates that roughly 17% of rural premises did not have download speeds of 10Mbps, compared to 1% in urban areas.[40] While we expect that commercial and Government-led rollout will help reduce this number, the disproportionate effect on rural premises will continue without further intervention. Defra's 2017 Rural England Digest[41] highlighted that rural areas have a significantly higher rate of home workers, with 34% in rural hamlets and dispersed areas compared to 13% in urban areas; one of the benefits of improved broadband is the ability to work from home more effectively.

There are also many homes and businesses in urban areas that cannot access 10Mbps for a variety of reasons. For instance, it may be very expensive to update infrastructure in the centre of towns and cities where closing roads and digging up pavements is costly.

[40] https://www.ofcom.org.uk/__data/assets/pdf_file/0035/95876/CN-Report-2016.pdf, figure 13 page 24
[41] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/670409/Statistical_Digest_of_Rural_England_2017_December_edition.pdf

3.1 Rationale - Market Failure

The broadband infrastructure market has many of the characteristics of a natural monopoly: very high fixed-costs, low marginal costs, and high barriers to entry. The provision of broadband infrastructure requires the construction and maintenance of a large, extensive, and diverse network – with high fixed capital costs. The majority of fixed infrastructure in the UK is owned by the BT Group, with fixed services provided over Openreach's network, and is subject to regulation of its wholesale products, including obligations on it to offer access to its local access infrastructure to other operators, and price controls.

Regulation has to a large extent been successful in limiting the monopoly power available, and ensuring an efficient and competitive retail market. The broadband market is largely a well-functioning and competitive market, with a choice of services for consumers available at a reasonable price. Firms such as TalkTalk, and Sky, have made use of BT's wholesale products to provide their own broadband services, leading to BT's retail market share being 32.6% in Q2 of 2017.[42] Smaller fixed and wireless operators such as Gigaclear, Hyperoptic, Relish and Quickline are also covering a growing number of premises .

However, there are areas of the country (generally, though not exclusively, the most remote and most difficult to reach) that are still on low speeds and cannot access 10Mbps download and 1 Mbps upload speeds, because there is no commercial incentive for broadband providers to build the necessary infrastructure or upgrade existing infrastructure. This lack of provision has negative effects on both the economy and society, and is partly due to the following market failures in the broadband market:

- Failure to take into account positive externalities associated with the universal provision of better broadband. Key examples being:
    a. the network effects available to firms, where a firm benefits if another firm it deals with becomes more efficient through using faster broadband),
    b. the environmental benefits not fully recognised through consumer choice, where increased cloud use and reduced travel (related to increases in teleworking and increased use of online services) leads to less pollution and reduced carbon emissions, and
    c. the wider benefits to the economy and society of equality in access to information, commercial and public online services through better broadband. Benefits stemming from better-functioning markets, better health outcomes and increased employment will not be fully incorporated into individual consumer choices.

  In other words, when considering purchasing an improved broadband connection, a firm may not factor in the productivity benefits to other firms, and a household may not consider the external benefits to wider society, in their decision. As a result consumers and end-user firms do not demand the socially optimal level of infrastructure and infrastructure providers therefore do not invest to the optimal level. Thus, Government intervention is necessary to facilitate the release of these benefits.

- Information failure - consumers (both households and end-user firms) are not fully aware of the extent of the benefits that improved broadband brings them, and therefore do not make optimal choices about purchasing a broadband connection. For example, not all businesses

[42] https://www.ofcom.org.uk/research-and-data/telecoms-research/data-updates/telecommunications-market-data-update-q2-2017

are aware of the extent of the productivity benefits that they would accrue from using faster broadband. Recent qualitative research[43] with residential broadband consumers also found that, while common drivers to upgrade were faster download speeds for entertainment services or facilitating home-working, a key improvement not fully taken account of before upgrading is increased reliability of the internet service, leading to more frequent use of online services. For example, the ability to use online shopping or banking without service disruptions.

- Information failure - suppliers also have imperfect information about the costs associated with infrastructure upgrades and level of take-up, as demonstrated through the Superfast Broadband programme. Of the £1.7bn of public funds committed through the programme, £200m is expected to be returned due to lower than expected costs and £500m through higher than expected take-up. This issue will be compounded by the use of Fixed Wireless technology which is currently not commonly used.

3.2 Rationale - Equity (reducing the digital divide)

The Government's Digital Strategy[44] sets out that people and businesses should be able to make use of digital services, and participate in the digital economy, wherever they are based. Part of the rationale for Government intervention is to address this concern.

The digital divide is the inequality in access to and use of information communication technology, across economic, social, or geographical boundaries. It manifests in the lesser ability of certain groups, particularly people who live and work in rural areas or hard to connect urban areas, to access the benefits that derive from access to these technologies. The divide also naturally widens over time; as digital technology and applications become more prevalent in life, those groups without access to fast, reliable speeds get left further behind.

This lack of access includes the digital economy (such as e-commerce, online banking, etc.), and the digital society (such as e-government, VoIP services, online news, etc.), and so has both economic and social consequences. Research has shown the link between technological access and economic growth. [45]

Much of the argument for addressing the digital divide is focussed on equality - access to the Internet tends to increase with wealth.[46] One of the effects of the digital divide is the growth in 'information poverty', where the less privileged do not have the skills or material means to access information, and apply it appropriately. Addressing this digital divide is a core part of the Government's digital ambitions, and a significant part of the rationale for this intervention. Improving access to broadband will help reduce the digital divide, reducing information poverty, and create social and economic benefits to consumers and businesses.

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[43] Research carried out for the evaluation of the Superfast broadband programme due to be published later in 2018

[44] https://www.gov.uk/government/publications/uk-digital-strategy

[45] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/85961/UK_Broadband_Impact_Study_-_Literature_Review_-_Final_-_February_2013.pdf

[46] http://www.pewinternet.org/2013/10/08/technology-adoption-by-lower-income-populations/

4. Policy Objective

The Government's objective is to reduce the digital divide, and to address the current market failure in the broadband market to give everyone access to a minimum level of broadband connectivity thereby improving social equity and productivity. The main market failures are set out in section 3.1, and result in under-provision, particularly in rural areas - although there are also failures in urban and suburban areas too.

By rectifying these market failures, the Government aims to improve social equality and economic growth. In terms of social equality, improving access to broadband in underserved areas will help to reduce the digital divide, by providing more equitable levels of internet access. This improved connectivity will allow people in these areas to access the digital economy and digital public services, and help them get connected with others. Further, it will enable more people to work from home effectively, creating economic, social, and environmental benefits. Better broadband will also improve the attractiveness of rural places as places to live, boosting local communities across the UK. Addressing under-provision should facilitate economic growth by improving the productivity of broadband-using firms, making remote working more viable and efficient, and increasing employment. Furthermore, it could help redistribute economic growth across regions. The CBI reports that "82% of firms said that the quality and reliability of the digital infrastructure were significant factors when they were deciding where to invest."[47] In other words, increasing the availability of improved broadband in rural areas (which tend to have worse broadband than non-rural areas), could encourage firms to invest there, boosting the local economy and helping to redistribute income across the whole of the UK.

5. Options

The Government has considered a broad range of both non-regulatory and regulatory options for ensuring that every household and business in the UK has affordable access to a broadband service with a level of functionality that meets the reasonable needs of the average UK home, and many small businesses. As a result of this, and in the light of experience from other interventions made, including the BDUK Superfast Broadband Programme and the Better Broadband Subsidy scheme, the Government has determined that a new broadband USO is the most appropriate tool for achieving this outcome. There was strong support for the introduction of a regulatory USO in the responses to the USO design consultation, as opposed to the non-regulatory alternative proposed by BT.

5.1 Options generation

As examined in Ofcom's technical advice on the USO[48], there are many factors to consider in the design and development of a new broadband USO, for example: the speed at which it is set and other quality requirements; the coverage it can give; the role of different technologies; what the costs might be; how it can be funded; and who the provider or providers might be. There are considerable variables within these factors and a high degree of dependency between them. The

[47] http://www.cbi.org.uk/media-centre/news-articles/2012/12/business-voice-will-the-uk-really-have-the-best-superfast-broadband-in-europe-by-2015/

[48] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/95581/final-report.pdf

primary variable factors, some of which are determined by the regulatory framework established by the EU Universal Service Directive, are:

- **Scope** - the number of premises that would be eligible to be connected under the new broadband USO. The Directive requires that all reasonable requests by end-users for connection should be met, independently of geographical location;
- **Technologies** - the method of delivery of the new broadband USO (fixed line, satellite, etc.) ;
- **Speed** - the minimum download and upload speeds that the USO would deliver. Ofcom has identified 10Mbps (along with other quality parameters, see below) as the 'minimum' download speed needed to meet the reasonable demands of the average UK household, and many small businesses, and this has been the starting point for our consideration of options. Additionally, a minimum upload speed may also be set. The Directive provides flexibility for Member States to define a broadband USO according to their own national circumstances, taking into account the prevailing bandwidth used by the majority of subscribers and technological feasibility, while seeking to minimise market distortion. It should provide a safety net in areas where the market is not delivering, and trails rather than leads the market;
- **Quality** - Wider quality parameters beyond minimum download and upload speeds are increasingly important for user experience. For example when streaming content, which is sensitive to delays and interruptions in the service, a connection which can offer a high speed but which is unreliable, or where the speed significantly drops at peak times may cause frustration. The quality of the broadband connection revolves around areas such as the reliability of the connection, capacity and the level of latency. Depending on the minimum service specifications which are set, the use of certain technologies would be ruled out, which could increase the cost of delivering a USO.
- **Funding** - The Directive provides for the designated Universal Service Provider (USP) to receive funding retrospectively to compensate any unfair net cost burden associated with providing the broadband USO. These costs can be met through industry or Government funding or a combination of the two. Under the Communications Act 2003, responsibility for the design of an industry cost-sharing mechanism has been delegated to Ofcom, which it will consult on as part of its USO implementation.
- **Provider(s):** which company or companies would be designated as a Universal Service Provider (USP) and would therefore be legally obliged to provide a connection and services under the USO. Under the Communications Act 2003, Ofcom is also responsible for determining which communications infrastructure provider or providers should be the designated USP(s);
- **Demand:** The combination of the speed, quality, and cost (per premise) will determine the level of take-up of broadband under the USO, as will promotion and awareness of the benefits. This will, of course, have a bearing on the total cost of the USO, a lower level of demand will result in a lower cost to industry, and/or a higher cost per premise.

The Directive also requires that in implementing universal service the principles of objectivity, transparency, non-discrimination and proportionality, are respected. The proportionality principle requires that:

a. The measure is appropriate and necessary in order to achieve the legitimate objective which it pursues;
b. when there is a choice between several appropriate measures, recourse is had to the least onerous measure; and
c. the disadvantages caused by the measure are not disproportionate to its aims.

On 30 July 2017, we published our consultation[49] on the design of a new broadband Universal Service Obligation (USO), which ran until 9 October. The consultation sought views on the specification for a new broadband USO that would be set in secondary legislation, drawing on the detailed technical analysis that the Government commissioned from Ofcom which was published in December 2016.

5.2 Description of chosen options.

A minimum download speed of 10Mbps has has been the starting point for our consideration of options for USO design. Ofcom advises that download speeds of at least 10Mbps, along with other quality parameters to ensure a good user experience, is the minimum level of broadband performance required for internet access to services such as web browsing, email and certain video services, which meets the needs of a typical family and many small firms. Below that level people's internet use is constrained.

<u>Do Nothing.</u>

This represents the counterfactual scenario, against which the other options have been compared. Under this option there is no broadband USO, so broadband coverage is determined by market forces. In addition, the BDUK programme will continue beyond having met the 95% coverage target at the end of 2017.

In 2017, approximately 1.1 million premises did not have access to download speeds of 10Mbps or higher and upload speeds of 1Mbps. This is around 4% of UK premises.

The size of the USO footprint is likely to reduce to some extent over time. BDUK estimates that further public and commercial investments could mean that at least 97% of the UK will have access to superfast broadband speeds by 2020. This is due to three main reasons:

1. Some premises without access to superfast broadband are in cities (where Government does not currently have a State aid compliant model for intervening). Many of these premises will be covered by the market, although some may not be reached in the short term, and Government will need to keep up the pressure on the key communications infrastructure providers (including Openreach, and Virgin Media) to ensure they continue to invest in urban areas between now and 2020. Ongoing commercial investment is expected to significantly reduce the number of urban premises who cannot get a connection which meets the USO specification.

2. Delivery is still underway through contracts under the Superfast Broadband Programme. Approximately 600,000 premises (2% of UK premises) are currently contracted to gain coverage through existing contracts, that is, beyond the 95% coverage at the end of 2017.

49 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/634016/USO_consultation_document.pdf

3. The Devolved Administrations and a number of English local authorities are currently undertaking new procurements to extend superfast broadband coverage or are expected to do so shortly. These projects will be funded using a range of funding sources including the remaining Superfast Broadband Programme funding, efficiency savings from previous contracts, clawback funding resulting from additional take-up, funding from the Defra Rural Development Programme for England, funding from the European Regional Development Fund, and new public funding commitments including the government's £150m funding for broadband in Northern Ireland and other commitments by the Devolved Administrations. It is difficult to estimate the superfast coverage that may be delivered through these procurements but it could potentially add a further 300,000 premises (1%) or more.

As discussed in 'problem under consideration', these three factors attach some uncertainty to the figures for eligible premises. However, this risk is abated to some extent by the fact that broadband rollout tends to follow the path of least resistance (ie connect the cheapest properties first) - given that those properties with sub-10Mbps access are likely to be more remote and therefore more difficult to cover than premises with access to 10-24Mbps, this extra 2-3% of superfast coverage might not greatly affect the number of premises remaining with less than 10Mbps by 2020. There is also significant uncertainty surrounding the forecasting of 2020s premise eligibility, which was undertaken in 2016 and has not been updated using the latest Connected Nations figures. Therefore, we are using the Connected Nations 2017 figures as a conservative estimate although due to the commercial and publicly-funded rollout between now and implementation this may be further reduced. Absent more accurate figures surrounding premises in the future this remains our counterfactual, although in Section 6.5 below we have undertaken some sensitivity analysis on potential reductions in the number of premises in scope.

There are some network services provided by satellite providers (and for many, supported by Better Broadband Subsidy Scheme funding) which are available to almost all premises. However, these services are often expensive compared with fixed network connections and the reliability and quality specifications might not always be comparable. For example, issues with latency can affect time sensitive applications.

Regulatory options

Four regulatory options were developed for the purpose of the consultation.

Option 1. 'Minimum' - 10Mbps Download speed, with no other quality standards

This option represents a connection with a download speed of 10 Mbps and no other quality specifications (such as upload speed). This is the lowest specification of the four regulatory options and therefore would be the least costly option. It is also likely to be the fastest to deliver. However, it would provide a lower quality of experience for end-users than the other options.. The cost model for this option assumes use of primarily FTTC technologies, however, Fixed Wireless Access, and satellite may be used.

Option 2. 'Preferred' - 10Mbps download, 1Mbps upload with other service specifications around latency, contention and data cap

This option aims to balance both the cost to the designated provider(s) and industry, and ensuring deliverability, with maximising coverage, and meeting consumer needs. Under this option, the designated provider(s) would be obliged to provide 10Mbps download speeds, with 1Mbps upload and some other service specifications to help ensure the quality of experience for people using online applications. The inclusion of an upload speed reflects the growing importance to consumers and businesses of services such as videoconferencing and video sharing, which need good upload, as well as download, speeds. However, the quality criteria are not as high as the minimum quality conditions for Options 3 and 4. FTTC, FTTP, fixed wireless and mobile could meet this specification based on current technical capabilities. It is in line with the speeds used by the prevailing majority of subscribers.

Option 3 - 20Mbps download and 2Mbps upload with other service specifications around latency, contention and data cap

This option represents a USO specification that is approaching superfast - with a higher quality connection, and higher cost method of delivery. Under this option, the designated provider(s) would be obliged to provide 20Mbps broadband, with an upload of 2Mbps, with service specifications. This higher speed option is expected to limit the use of some technologies as a means of delivery based on their current capabilities. Due to issues of practicality this would mean that mixed-fibre technologies, such as FTTC (VDSL2) or FTTP, are the most likely methods of delivery.

Option 4. 'Maximum' - Superfast 30Mbps download, 6Mbps upload with quality specifications for latency and contention

This option represents a superfast specification - the highest quality of the options, and highest cost of delivery overall. Under this option, the designated provider(s) would be obliged to provide 30Mbps broadband, with some specific quality conditions specified up to a high cost threshold. The quality conditions applied are expected to limit the use of some technologies as a means of delivery based on their current capabilities. Due to issues of practicality and scalability (outlined in the technology annex), we assume that this would mean that mixed-fibre technologies, such as FTTC (VDSL2) or FTTP (GPON), are the most likely methods of delivery.

Table 2. Comparison of regulatory options

	Option 1	**Option 2**	**Option 3**	**Option 4**
	Standard broadband (10Mbps download speed)	More highly specified standard broadband (10Mbps download + 1Mbps upload)	More highly specified standard broadband (20Mbps download + 2Mbps upload	Superfast broadband (30Mbps download + 6Mbps upload)
Download speed[50]	10Mbps	10Mbps	20Mbps	30Mbps
Upload speed	None defined	1Mbps	2Mbps	6Mbps
Latency[51]	None defined	Medium response time	Medium response time	Fast response time
Contention ratio[52]/	None defined	50:1	50:1	CIR 10Mbps

[50] The sync speed is the maximum speed that is achievable between the Internet Service Provider's (ISP's) access network and the consumer premises. In reality, the actual speed that is provided to an end user is typically lower than the sync speed. This varies depending on the amount of contention in the network at that point in time, and to other factors such as quality of in-home wiring

[51] Latency is the round trip delay in the transmission of data. In particular, this can affect the performance of live applications, such as live video streaming, gaming and video calling/conferencing.

[52] Contention is the degree to which bandwidth is shared between different end users at the same network node

Committed Information Rate				
Data usage rate[53] (monthly)	None defined	100GB	100GB	Unlimited

Reasonable Cost Threshold

The connection to each premise will be subject to a 'reasonable cost threshold'. If the cost of the connection is above this threshold, there is no obligation on the provider to make the connection (unless the consumer is willing to pay the excess). We have chosen to set a cost threshold to ensure that the intervention is proportionate and minimises market distortion.

Consideration was also given to setting a coverage target, but we took the view that a cost threshold was preferable as it makes clearer to consumers the criteria for getting connected. A coverage threshold does not provide clarity for consumers or those in industry contributing to the industry cost sharing mechanism.

The level the cost threshold is set plays an important role in determining the overall impact of the policy. It will have a direct impact on the number of premises eligible for connection (the scope), and, consequently, the costs of delivering the USO. Furthermore, the effect on cost will depend on the exact level at which this cost threshold is set. The relationship between cost threshold and scope is simple: the lower the cost threshold, the lower the number of premises eligible for connection (the smaller the scope), and, consequently, the lower the cost of delivering the USO. The consultation proposed that the cost threshold should be set at £3400. Illustrative alternative reasonable cost thresholds have been used to inform the analysis below.

Non-Regulatory Options

There are two main avenues for delivering the USO via non-regulatory solutions. The first is a voluntary industry delivery, and the second is a state-funded intervention.

a) **Non-regulatory industry delivery** - The Government had previously set out its clear intention to legislate, and included enabling powers for the introduction of a broadband USO in the Digital Economy Act 2017. However, it made clear that it would consider any robust proposals for an industry-led solution. On 30 July 2017, it was announced that BT had made a non-regulatory proposal for delivering universal broadband to premises across the UK[54]. BT subsequently published a briefing providing some further details on its offer to Government[55]. The proposal provided for fixed broadband roll out to 98.5% of premises in 2020 rising to 99% in 2022; 0.7% of premises would have access on demand to fixed wireless broadband in 2020. The remaining 0.8% of premises in 2020 would have the option of satellite broadband reducing to 0.3% of premises in 2022 once the fixed roll out is completed.
BT proposed recovering its fixed broadband roll out costs through regulated wholesale local access (WLA) pricing. On 9 August, Ofcom, who is responsible for regulating the WLA

[53] Providers use data caps to manage the amount of data consumers use. Consumers tend to be charged more if they exceed their data caps

[54] https://www.gov.uk/government/news/universal-broadband-to-reach-every-part-of-the-uk

[55] https://www.openreach.co.uk/orpg/home/updates/downloads/Deliveringuniversalbroadbandcoverage.pdf

market, published a consultation on its proposals for allowing Openreach to recover its costs in the event that the Government accepted BT's proposal over a regulatory USO[56]. However, having given careful consideration to BT's proposal, it was announced on 20 December 2017 that while grateful to BT for its proposal, the Government preferred to pursue a regulatory USO. The Government had always been clear that their decision on which delivery route to take would be guided by the best interests of consumers and small businesses. Government gave careful consideration to BT's proposal because of the potential benefit of delivering a roll-out programme of fixed broadband roll-out, complemented by fixed wireless access. However, BT's proposal ultimately did not provide sufficient certainty that Government's commitment to provide access to universal high speed broadband by 2020 would be delivered and enforced.

b) **Public funding** - the UK has already invested £1.7 billion in broadband rollout, which has taken coverage to a further 4.75 million premises by the end of 2017. The Government has also changed the planning framework to make it easier for broadband operators to deploy in challenging areas, for example, through relaxing the siting requirements for broadband cabinets and overhead lines[57], reformed the Electronic Communications Code which governs rights of access to private land, and through implementation of the EU Broadband Cost Reduction Directive.[58] These measures are designed to help reduce the cost of broadband deployment and improve the business case for commercial investment. We will continue to look for ways to support further industry investment in connectivity for the UK.
Given continued pressures on public funding, and substantial investment to date and committed in the future, the Government thinks it is right for industry to fund delivery of universal high speed broadband. Our view is that a cost-sharing mechanism which allows costs to be shared across a number of industry players ought to support delivery of the USO without overly burdening industry or any one single provider. Ofcom would be responsible, after consultation, for designing the industry fund, and who should contribute to that fund. Ofcom has a duty under section 71 of the Communications Act 2003 to ensure that the cost-sharing mechanism is objectively justifiable, non-discriminatory and causes the least distortion of competition or consumer demand. Under the Universal Service Directive contributions may only be sought from companies providing electronic communications networks or services. In their technical advice to Government on the design of the USO, Ofcom said there were broadly three sets of providers that could be required to contribute: fixed broadband providers; fixed broadband and mobile providers; or all providers of an electronic communications network or service. The factors they would consider when deciding which providers to include were set out in Figure 9.2 of their report[59].

A further consideration is that a regulatory solution provides a future-proofed and more comprehensive solution, as once the USO in place, it can be reviewed and upgraded as market needs change. As noted previously provision has been made for this in the enabling measures in the Digital Economy Act 2017, which includes a formal review commitment when superfast broadband is taken up by 75% of premises.

[56] https://www.ofcom.org.uk/consultations-and-statements/category-2/wholesale-local-access-market-review-recovering-the-costs-of-investment-in-network-expansion
[57] https://www.gov.uk/government/consultations/proposed-changes-to-siting-requirements-for-broadband-cabinets-and-overhead-lines-to-facilitate-the-deployment-of-superfast-broadband-networks
[58] http://www.legislation.gov.uk/uksi/2016/700/contents/made
[59] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/95581/final-report.pdf, p 57

6. Costs and Benefits

6.1 Cost Model Methodology

The estimation of the main quantifiable costs of the USO have been calculated using a specifically designed economic model. The model was created for the December 2016 Ofcom report 'Achieving decent broadband connectivity for everyone' by Analysys Mason, to measure the impacts of a broadband USO of varying speeds and quality requirements. What follows is a brief description of how the model works. A detailed exposition of the methodology used by Analysys Mason is available in their report, found at annex 6 of Ofcom's report[60]. In July 2017, Ofcom published an update to the analysis that included an additional option (as requested by DCMS) and corrected a modelling error for one specific technology (long-range VDSL). However, the underlying model and data remained the same. The updated cost estimates can be found in 'Technical advice on a broadband USO: Updated cost estimates'[61].

The foundation of the model is estimating the distribution of premises and current broadband infrastructure across the entirety of the UK. The basis for the modelling is postcode-level data on premises as at Q1 2016 for the four options described above, producing an estimate of the total deployment costs using a range of different eligible technologies.

Ofcom's report summarises the methodology used as follows:

- Identifying the postcode areas which contained potentially eligible premises;
- Aggregating these postcodes into groups defined by the area covered by the cabinets which serve them (the cabinet serving area);
- Assessing the availability of existing fixed network infrastructure for premises in these areas;
- Assessing the network infrastructure that would need to be deployed under each of the different technological solutions in each cabinet serving area in order to meet a specific technical specification; and,
- Using the average cost per premises connected in each group of postcodes for each of the different technology options for each technical specification to derive an overall estimate of the total costs.

By using the postcode level data and cabinet data it is possible to estimate the speeds currently available to these premises in the UK, and the nature of the infrastructure connecting each premise. Further, it can then estimate the new infrastructure needed to increase the speed available to any premise, from wherever it is now to any other speed. This is based on another large data set that gives the capability of different technologies and how they can be deployed.

From this estimation of what is needed to get each premise to the required level, the model estimates the cost, which is based on another data set that has estimates of costs for each part of the infrastructure. Finally, after estimating the individual costs, the model aggregates these costs to

[60] https://www.ofcom.org.uk/__data/assets/pdf_file/0027/95580/annex6.pdf
[61] https://www.ofcom.org.uk/__data/assets/pdf_file/0015/105342/Technical-advice-on-a-broadband-USO-Updated-cost-estimates.pdf

estimate the total cost of the rollout. This includes the capex required to deploy the incremental network assets to serve eligible premises, annual opex to operate the incremental network, and any additional core network costs (i.e. additional costs through additional traffic on the existing network). The outputs from this modelling provides the starting point for our updated cost calculations as set out below. Since the model is set to connect the cheapest premises first, we can also estimate the impact of different cost thresholds on numbers of premises connected (or left unconnected). Furthermore, by plotting the cumulative cost of connecting each premise as they are connected, we can estimate a cost curve of total cost against coverage.

6.2 Input Assumptions and Data Sources

The Analysys Mason model is underpinned by several datasets and numerous assumptions. The key overarching assumptions and data sources are set out below, with references to the Analysys Mason report to provide more detail.

Premises in Scope: For each option Ofcom provided to Analysys Mason a list of all postcodes which contained premises that, as of June 2016, were believed not to be able to receive a fixed broadband service that met the specification of that option. This was based on data collected from operators by Ofcom to deliver its Connected Nations report in late 2016. To model the incremental network required to deliver the USO these postcodes were then aggregated to their serving cabinet (or serving exchange in cases of exchange-only lines). This enabled bottom up modelling of the infrastructure required to connect these postcodes to take place. The number of premises in scope of each option is set out in Table 1 (Section 3) above, although it should be noted that some of these figures have been updated since the original modelling, requiring the adjustments set out in section 6.3 below. Section 3 (pages 50-53) and Annex B of the Analysys Mason report[62] provides further detail on the data that was provided to Analysys Mason by Ofcom and the geographical approach to their modelling.

Infrastructure Unit Costs: Analysys Mason constructed their unit cost dataset using international benchmarks alongside data from BDUK Market Test Pilots[63] and Openreach. As it is unclear who would take on the responsibility of becoming the USP this dataset aimed to strike a conservative balance between the prices available to a major network builder who can buy at scale, and the prices available to local network builders who do not have similar scale but can sometimes access advantageous low costs because of strong local goodwill and relationships (e.g. land owners agreeing to receive compensation in kind). The unit costs vary by each technology that may be used to fulfil the obligations of the USO and are set out in detail in section 4.2 (pages 58-70) of the Analysys Mason report[64]. An example of the unit costs used for one particular technology (Fibre-to-the-Cabinet) is displayed below (all abbreviations and acronyms used are set out on pages iii to iv of the report).

[62] https://www.ofcom.org.uk/__data/assets/pdf_file/0027/95580/annex6.pdf
[63] https://www.gov.uk/government/publications/superfast-broadband-programme-phase-3
[64] https://www.ofcom.org.uk/__data/assets/pdf_file/0027/95580/annex6.pdf

Figure 4.10: FTTC assets [Source: Analysys Mason, 2016]

Asset description	Unit capex (2016 GBP)	Annual opex (2016 GBP)	Lifetime (years)	Nominal price trend
Trench – feeder, built, ducted (m)	57	2	50	3%
Trench – feeder, built, direct buried (m)	52	2	20	-2%
Trench – feeder, rented, ducted (m)	3	0.5	20	-2%
Fibre cable sheath for ducting – 72F (m)	3	0.1	20	-2%
Fibre cable sheath for direct bury – 72F (m)	3	0.1	20	-2%
FTTC cabinet (2 rack capacity)	7900	200	15	4%
FTTC cabinet (up to 4 rack capacity)	8500	280	15	4%
VDSL2 DSLAM line card (32 port)	550	60	6	-5%
VDSL2 DSLAM rack (2 line card capacity)	7200	560	6	-5%
LR-VDSL DSLAM line card (32 port)	550	60	6	-5%
LR-VDSL DSLAM rack (2 line card capacity)	7200	560	6	-5%
ODF port	16	3	20	-4%
OLT port	35	9	5	–

<u>Network Dimensioning:</u> For each technology Analysys Mason model the most efficient way that it could be rolled out to serve the premises identified as in scope. This is a bottom-up modelling exercise that takes the location of existing assets (such as cabinets and exchanges) and estimates what additional infrastructure would be needed to reach the premises in scope for each option. This requires numerous assumptions and calculations which need to be made for each technology, resulting in a modelled hypothetical network that can deliver the connection specification required. For example, for a Fibre-to-the-Premise network fibre would need to be laid down most public roads which face premises, so the road network length within each relevant postcode group was calculated while making assumptions around which classes of roads were most likely to be faced by premises (i.e. motorways and A roads were excluded but B roads and unclassified roads were included). The approach to network dimensioning and the assumptions made for each technology are set out in detail in section 4.2 (pages 58-70) of the Analysys Mason report[65]. For each technology the report provides a flow diagram overview of the network dimensioning process and an example for one particular technology (Fibre-to-the-Premise) is displayed below (all abbreviations and acronyms used are set out on pages iii to iv of the report).

[65] https://www.ofcom.org.uk/__data/assets/pdf_file/0027/95580/annex6.pdf

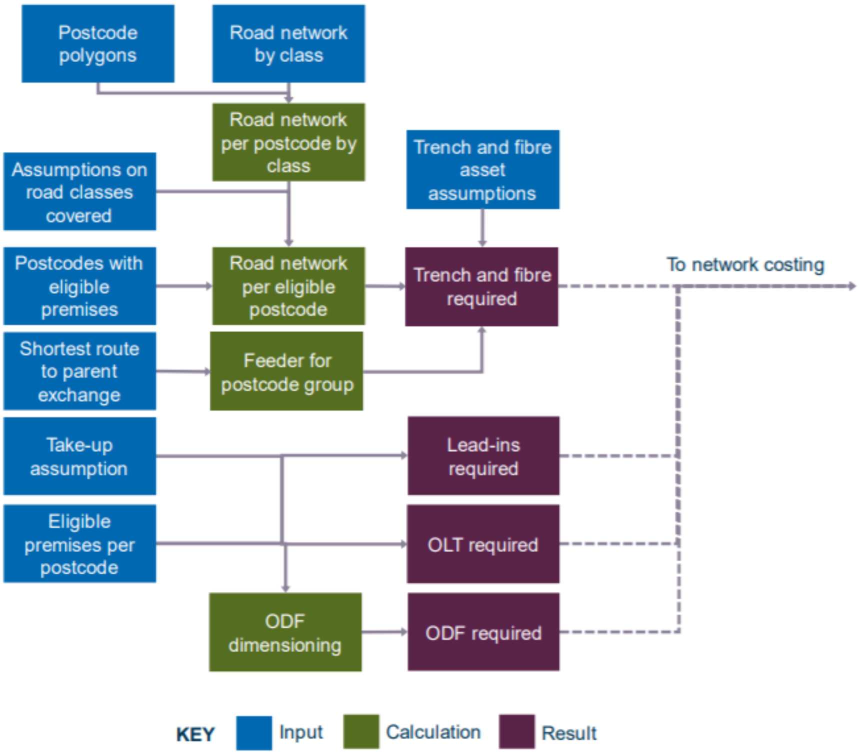


Figure 4.5: Overview of FTTP GPON asset dimensioning [Source: Analysys Mason, 2016]

Demand**:** Given that the regulatory USO will be demand-led, it is important to understand how many people will actually request to be connected. There are a number of sources and some historical examples from which we can draw estimations of demand, including retail broadband demand, superfast demand from BDUK programmes, Market Test Pilots, and connection voucher schemes. However, Ofcom note 'The assumption about take-up has the effect of meaning that the bottom-up model is not a strict 'on-demand' model as it presumes that network will be built in an area, and then made available to whoever demands it. In effect, it is more like a network deployment undertaken with effective demand aggregation.'[66] The long term level of take up of broadband services is around 80%, therefore the assumption of take up in the model is also 80%.[67]

Distribution of demand: Given that demand is less than 100%, an assumption is required about where that demand is. The assumption used, in line with Ofcom estimates, is that it will be distributed geographically evenly across remaining premises, i.e. 80% of eligible premises in each postcode, rather than every premise in 80% of postcodes. Some aggregation will occur in some areas, where, for example, there is a community-led information campaign, and some areas will have less than 80% demand, and some higher, but the central estimate is of even distribution.

Demand aggregation: Aggregation is the term for the significant economies of scale that can be achieved when building broadband infrastructure. In many cases, the infrastructure needed to connect one premise (such as a fibre connected street cabinet) is capable of connecting many more nearby for a relatively low marginal cost. This infrastructure tends to have a large up-front capital cost, which means that the first premise to be connected is very expensive, but due to the low

[66] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/95581/final-report.pdf , page 43, Ofcom December 2016 report

[67] This is in line with the approximate current level of take-up of broadband services in the UK. It is rounded from 78% in Ofcom's Connected Nations 2015 report (paragraph 4.26) and is also consistent with the level of take-up reported in the 2016 Connected Nations. https://www.ofcom.org.uk/__data/assets/pdf_file/0028/69634/connected_nations2015.pdf

marginal cost, for every extra premise that is connected to that new infrastructure, the average cost per premise falls rapidly. In this way, the total cost of delivery is likely to be very similar for demand of 20%, 80% or 100%, given the even distribution of demand. There will be some areas where aggregation cannot occur, for example, where the connection to a premise is straight to the exchange, but the central assumption is that the total cost estimated by the model (which assumes 80% demand) will still hold even if demand is significantly different. This also means the cost estimates provide an upper limit for a broadband solution so even if demand were a lot higher, costs would not be.

6.3 Steps for updating cost modelling

The cost modelling undertaken by Analysys Mason has been updated for this final stage IA to reflect new information. The biggest difference is the availability of updated estimates for the number of premises in scope, as provided by Ofcom as part of its recent 2017 Connected Nations report.

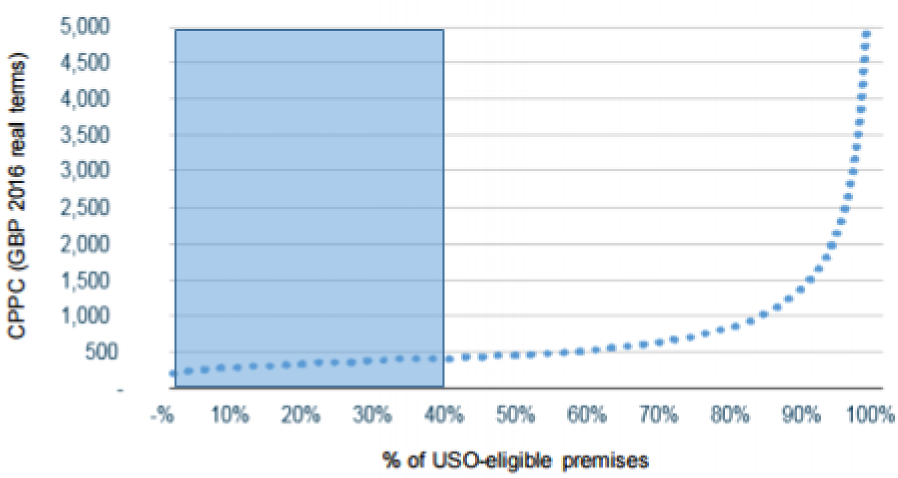
1. To account for updated estimates for the number of premises in scope, the cost curves estimated as part of the original Analysys Mason work have been derived and then extended or shortened to account for the addition or reduction of premises in scope. In the absence of the underlying data, we quality-assured our derived cost curve by calculating the outputs previously estimated for 2016 and 2017.
2. Where there is a greater level of coverage than previously estimated (i.e. a reduction in premises in scope) it is assumed this has been achieved by connecting the cheapest premises first (reflecting previous broadband rollouts).
3. As a result, where premises in scope have decreased the updated analysis effectively “cuts off” the cheaper tail end of the cost curve, leaving fewer premises with more expensive costs per premise.

For example, the cost for option 2, 2017, was previously estimated at £1.46 billion (with no threshold or optimism bias applied). This was based on 1.8 million premises being in scope. These figures can be found in the document ‘Technical advice on a broadband USO: Updated cost estimates’[68] in Figure 8.1 (for costs, rounded to £1.5bn in this table) and Figure 4.4 (for premises in scope) - in the column headed Scenario 2 and the row titled End of 2017.

As mentioned above, the cost curves from the original Analysys Mason modelling[69] provide the basis for the update. The Connected Nations 2017 report confirmed a reduction in premises in scope for Option 2 from a previously estimated 1.8 million to 1.1 million. We effectively “cut off” the bottom of the curve to account for this, as illustrated below. This provides a new cost of approximately £1.27 billion with no reasonable cost threshold. With optimism bias applied (method laid out in section 6.6 below), this produces a total cost of £1.52 billion.

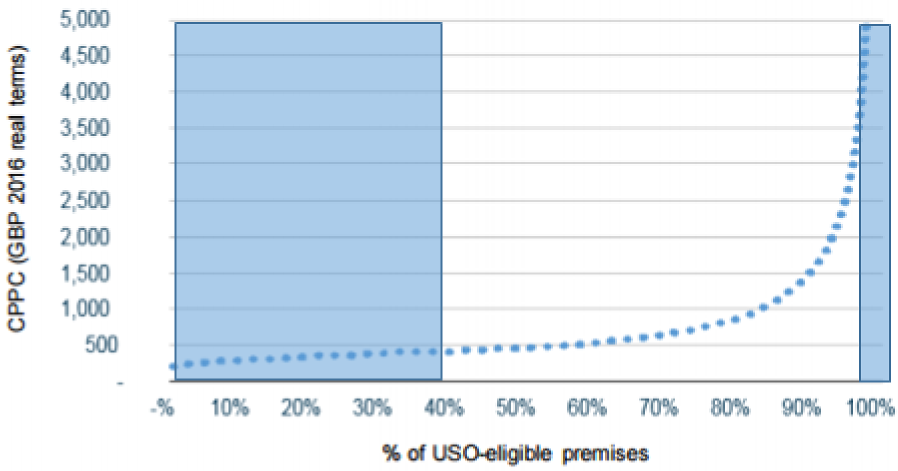
The reduction in premises in scope from 1.8 million to 1.1 million cuts off the bottom of the curve.

[68] https://www.ofcom.org.uk/__data/assets/pdf_file/0015/105342/Technical-advice-on-a-broadband-USO-Updated-cost-estimates.pdf
[69] https://www.ofcom.org.uk/__data/assets/pdf_file/0027/95580/annex6.pdf



We then apply the £3,400 cost threshold. This effectively cuts off the top of the curve and produces a cost of approximately £850 million. With optimism bias applied (method laid out in section 6.6 below), this produces a total cost of £1.02 billion. The same principles are applied for all options to produce updated costs dependent on the change in premises in scope.

Applying the threshold effectively cuts off the top of the cost curve.



6.4 Costs

Our central cost estimates are based on the number of premises in scope in 2017, as estimated in the latest Ofcom Connected Nations report. However, by the time the USO is implemented and consumers can begin to make requests for connection the footprint is likely to be smaller, so these costs represent an upper bound. The projected reduction in eligible premises from 2016 - 2020s is shown in Table 1 (page 15). Using the number of premises in scope, and the cost per connection the total cost of rollout for each option is estimated.

Option 1. 'Minimum' - 10Mbps download

Under option 1, there would be no additional service specifications attached to the broadband service. Our assumption is that the provider will use a mix of technologies capable of providing 10Mbps, as it is much cheaper to use a mix of technologies rather than a single technology, to deliver the USO. The cost of the minimum option is therefore the lowest cost mix of technologies capable of providing a 10Mbps connection.

Scope: The central estimate is that there are 942,000 premises in the scope of this proposal.

Total Cost: The total cost of option one is estimated to be **£1.01bn** without a reasonable cost threshold (2016 real prices, undiscounted) based on eligibility in 2017 (this does not assume delivery via satellite other than for the very hardest to reach premises). Naturally as time goes by and more premises have access to a 10Mbps connection under commercial rollout or publicly-funded programs, such as the Superfast Broadband Programme, the overall cost will decrease to some extent.

Option 2. 'Preferred' - 10Mbps download, 1Mbps upload and quality conditions

In addition to minimum download speed of 10Mbps, further minimum quality conditions are specified for latency, contention and data cap requirements.

Scope: The central estimate is that there are 1.1m premises eligible.

Total cost: The total cost of delivering this option is **£1.27bn** without a reasonable cost threshold (2016 real prices, undiscounted). As with the above options, as each year goes by fewer premises are eligible to connect under the USO as commercial or alternative government programmes are rolled out in their areas, this in turn brings USO costs down.

Option 3. - 20Mbps download, 2Mbps upload

This option is approaching superfast speeds, where the provider is obliged to provide broadband up to a much higher specification with download and upload specifications, and quality parameters for contention and latency, however, these are lower than for option 4 below.

Scope: The central estimate is that there are 2.2m premises eligible.

Total cost: The model estimates that the cost of connecting every remaining premise to 20 Mbps broadband in 2017 using the cheapest technology mix solution is **£1.63 billion** without a reasonable cost threshold (2016 real prices, undiscounted).

Option 4. 'Maximum'- Superfast 30Mbps download, 6Mbps upload and 10Mbps CIR

Option 4 represents the 'do maximum', where the provider is obliged to provide broadband connections with a much higher specification.

Scope: The central estimate is that there are 2.7m premises eligible.

Total cost: The model estimates that the cost of connecting every remaining premise to superfast broadband in 2017 using a fixed wire solution as **£1.90 billion** without a reasonable cost threshold (2016 real prices, undiscounted).

Summary Table: Premises in Scope and Total Cost of Each Option (without a reasonable cost threshold)

	Premises in scope	**Total Cost (2016 real prices, undiscounted)**

Option 1. 'Minimum' - 10Mbps download	942,000	£1.01bn
Option 2. 'Preferred' - 10Mbps download, 1Mbps upload and quality conditions	1,100,000	£1.27bn
Option 3. - 20Mbps download, 2Mbps upload	2,200,000	£1.63bn
Option 4. 'Maximum'- Superfast 30Mbps download, 6Mbps upload and 10Mbps CIR	2,700,000	£1.90bn

6.5 Cost Tables and Graphs

Impact of cost threshold

The figures above provide modelled total cost estimates for delivery of each option if it was delivered in full (i.e. to 100% of premises). However, the implementation of a threshold that caps the cost per connection faced by a provider limits this total cost.

The level the cost threshold is set plays an important role in determining the overall impact of the policy. In particular, the imposition of a cost threshold will mean that a number of the most expensive premises to connect would not be eligible. This contributes to ensuring that the intervention is proportionate. Imposition of a cost threshold would therefore reduce the overall cost and thus the net cost to be met through the industry cost-sharing mechanism. Given the decision that the costs of delivering the USO should be met by industry, we can assume that some or all of these costs will be passed on to consumers.

Policies on universal availability often include such caps:

- For the voice telephony universal service, the cost threshold is £3,400 - where connection costs are above this threshold, consumers are given the option of paying the amount above it. This is known as an 'excess construction charge'.
- Similarly, Digital Terrestrial Television (DTT) coverage is set at 98.5% of UK homes.
- Water services also have a reasonable cost threshold applied, resulting in availability of less than 100%. Water companies are entitled to recover the "reasonable costs" of making a water or sewerage connection - this varies by provider. For example, the 2015-16 maximum reasonable cost contributions that Scottish Water will provide for domestic dwellings is £1,555.31 for water and £1,805.35 for sewerage[70].

[70] http://www.scottishwater.co.uk/you-and-your-home/your-charges/2015-2016- charges/information-about-your-charges-201516/rcc-for-dwellings-201516

We have also considered setting a coverage target rather than a specific cost threshold in order to cap the costs of delivering the USO. Of the two options, our view is that a financial cost cap rather than a coverage target will make it clearer to consumers the criteria for them getting connected (or not), so we have selected this over an explicit coverage target.

As part of Analysys Mason's modelling, they provided some illustrative examples of the cost and coverage resulting from different cost thresholds: £3,400, £5,000 and £10,000. In our USO design consultation, we proposed a cost threshold of £3,400 as the most proportionate threshold, as it would achieve c99.8% premises coverage. Above this level, the costs of connecting the most difficult to reach premises rise exponentially, as illustrated by the cost curves in the section below. A range of views were expressed in response to the consultation: some called for it to be set at a lower level, while others called for it to be set at a higher level to increase the number of premises within scope of the USO. The majority of respondents, however, agreed with the cost threshold being set at £3,400.

In light of this analysis, and our policy objective of ensuring universal coverage (or as universal as possible) while minimising market distortion, we remain of the view that £3,400 is an appropriate threshold for the introduction of the USO.

We have also considered the costs that BDUK have identified in the recent, that is to say later, stages of its deployment of superfast broadband to 95% of the country. While specific deployment figures from the programme are commercially sensitive, and therefore confidential, we can indicate that the the cost per premise trajectory has been increasing significantly as deployments increasingly extend into very hard to reach areas, and suggest that a cost threshold of £3,400 is justified.

The policy objective is to maximise coverage, and £3,400 cost threshold would provide for 99.8% coverage. We think this balances achievement of the policy goal with deliverability, including impacts on industry and consumer prices.

Premises in Scope and Total Cost of Each Option (with a reasonable cost threshold of £3,400)

	Premises in scope	**Total Cost (2016 real prices, undiscounted)**
Option 1. 'Minimum' - 10Mbps download	880,000	£0.66bn
Option 2. 'Preferred' - 10Mbps download, 1Mbps upload and quality conditions	1,050,000	£0.85bn

Option 3. - 20Mbps download, 2Mbps upload	2,100,000	£1.20bn
Option 4. 'Maximum'- Superfast 30Mbps download, 6Mbps upload and 10Mbps CIR	2,600,000	£1.37bn

Premises in Scope and Total Cost of Option 2 (with a range of different cost thresholds)

	Premises in scope	**Total Cost (2016 real prices, undiscounted)**
Option 2 with £1,500 cost threshold	980,000	£0.67bn
Option 2 with £2,200 cost threshold	1,010,000	£0.73bn
Option 2 with £3,400 cost threshold	1,050,000	£0.85bn
Option 2 with £5,000 cost threshold	1,090,000	£1.05bn

The purpose of these tables is to show the varying level of coverage that is achieved with a varying cost threshold.

These cost figures also make no allowance for consumers paying excess costs above the cost threshold, regardless of the level it is set at. Some consumers may be willing to pay, or do some of the installation work themselves to reduce their costs, and so in that case the total cost to the designated providers will be higher (by the number of willing consumers multiplied by whatever the cost threshold is). There is little relevant or recent evidence on the amount that consumers would be willing to pay above a cost threshold. Some illustrative levels of uptake are set out below with the associated cost to the USO provider based on a £3,400 cost threshold.

Illustrative additional costs for the USO provider associated with take up of connections above a £3,400 cost threshold

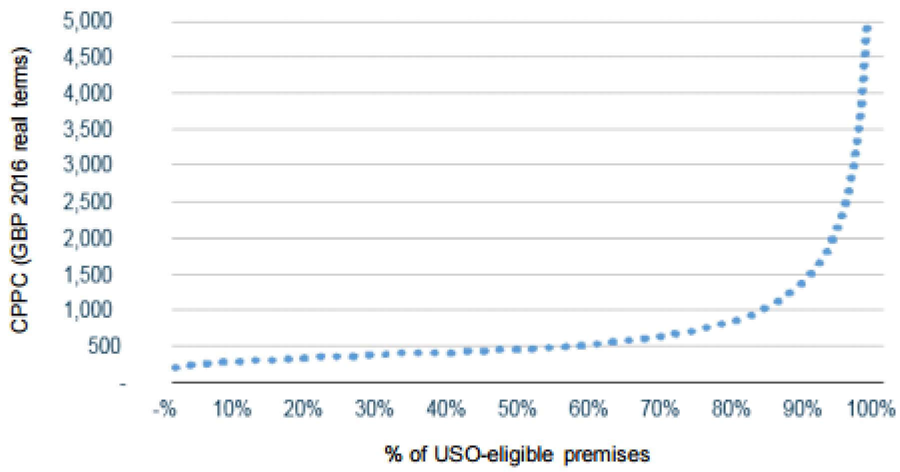
Number of connections	**Cost to USO provider**
1,000	£3.4m

2,000	£6.8m
5,000	£17.0m
10,000	£34.0m

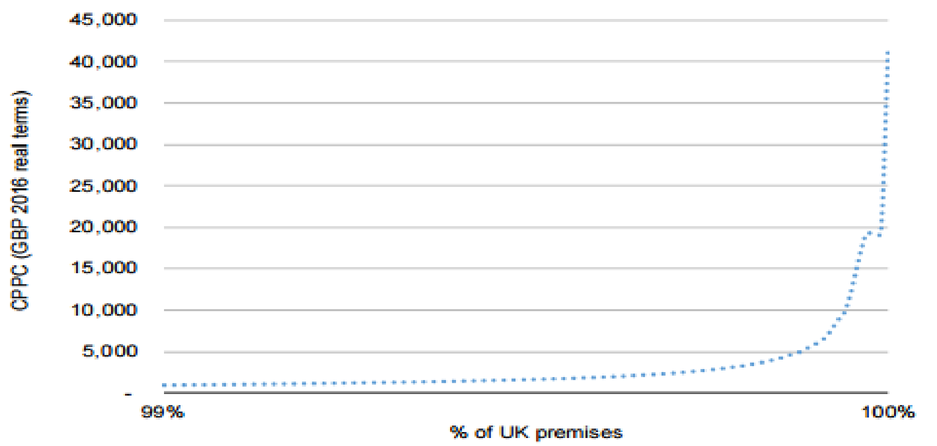
<u>Cost Curve</u>

The graph below shows the relationship between total cost and the number of premises connected. The relationship is exponential, as the marginal cost of connecting every extra premise increases at a faster rate for each premise connected. The cost curves were produced as part of Analysys Mason's original analysis - they are only for option one using the original 2016 estimate of premises in scope, but it can be reasonably assumed that a similarly shaped curve would apply across all four options because of the costs of deploying fixed infrastructure in remote hard-to-reach areas. These cost curves were used as the basis for updating the cost analysis to take account of updated premises in scope using 2017 data.

Cost per premises connected option one, 2016 (original Analysys Mason modelling)



Cost per premises connected - final 1% of UK premises, option 1, 2016 (original Analysys Mason modelling)



Sensitivity Analysis

The choice of cost threshold is the most significant factor that determines overall cost for each option. However, there are also a number of assumptions that influence the total cost. The most notable is the number of premises in scope, and in particular how the counterfactual may develop with further commercial rollout. Two other assumptions of note within the cost model are the level of demand/take-up and the fibre feeder distance. The tables below set out the impact of changes in these assumptions on the total costs. These are based on original analysis undertaken for the consultation by a combination of Ofcom, Analysys Mason and DCMS. They have been updated to reflect the latest overall cost figures (without a cost threshold) by applying the percentage differences from the original analysis to the updated costs.

Premises in Scope

As set out above in Section 3 under scope and Section 5.2 under the do nothing option there is some uncertainty over the impact of future broadband rollout on the number of premises in scope. As part of Ofcom's 2016 report 'Achieving decent broadband connectivity for everyone'[71] there was provided some speculative estimates of how many premises may be in scope of each option by the "early 2020s". There was a high degree of caution placed on these estimates however, as information on potential commercial or subsidised rollout is not developed or specific enough to carry any degree of confidence. In addition, the "early 2020s" is beyond the point when the USO will be fully operational, which is aimed to be in early 2020 itself. Therefore, the 2017 figure for premises in scope is taken as both the best estimate and the upper bound for estimating the costs and benefits. Given the uncertainties we have undertaken sensitivity analysis on the potential costs, modelling potential 10% and 30% reductions in premises in scope across each option, as well as the 2016 Ofcom estimate for the early 2020s. As explained in Section 3 under scope and Section 5.2 under the do nothing scenario, such reductions are more likely to be experienced for options 3 and 4 because of further superfast rollout, than options 1 and 2.

Impact on total costs (with no cost threshold) for each option of a reduction in premises in scope - total cost (2016 real prices, undiscounted)

[71] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/95581/final-report.pdf

	2017 premises in scope	10% reduction in premises in scope	30% reduction in premises in scope	Ofcom estimate of premises in scope by 2020s
Option 1. 'Minimum' - 10Mbps download	£1.01bn	£0.97bn	£0.88bn	£0.69bn
Option 2. 'Preferred' - 10Mbps download, 1Mbps upload and quality conditions	£1.27bn	£1.22bn	£1.10bn	£1.01bn
Option 3. - 20Mbps download, 2Mbps upload	£1.63bn	£1.59bn	£1.48bn	£1.23bn
Option 4. 'Maximum'- Superfast 30Mbps download, 6Mbps upload and 10Mbps CIR	£1.90bn	£1.84bn	£1.67bn	£1.44bn

Demand

As set out above the central assumption on demand is that there will 80% take-up based on the overall take-up of broadband services in the UK. For the sensitivity analysis below this is varied to 55% for high speed broadband and 30% for superfast. It shows that even with a dramatic drop in demand costs do not fall by a particularly large amount as the overall infrastructure required to reach those that do demand a connection is largely unchanged.

Impact on total costs (with no cost threshold) for each option of a reduction in demand

	Total Cost (2016 real prices, undiscounted)	Total Cost with reduced demand (2016 real prices, undiscounted)	Percentage difference in costs
Option 1. 'Minimum' - 10Mbps download	£1.01bn	£0.97bn	-4%

Option 2. 'Preferred' - 10Mbps download, 1Mbps upload and quality conditions	£1.27bn	£1.20bn	-6%
Option 3. - 20Mbps download, 2Mbps upload	£1.63bn	£1.47bn	-10%
Option 4. 'Maximum'- Superfast 30Mbps download, 6Mbps upload and 10Mbps CIR	£1.90bn	£1.63bn	-14%

Fibre Feeder Length

Fibre feeder trenches which link the exchange to the broadband cabinet are one of the most expensive components of a fixed wired connection with per metre costs of trenching costing between £30-£66. Therefore, if the feeder length increases from 2km to 10km this represents a significant increase in cost. The table below details the change in cost should the fibre feeder length change from the assumed 2km in the model to the worst case scenario of 10km.

Impact on total costs (with no cost threshold) for each option of an increase in fibre feeder lengths

	Total Cost (2016 real prices, undiscounted)	**Total Cost with 10km fibre feeder length (2016 real prices, undiscounted)**	**Percentage difference in costs**
Option 1. 'Minimum' - 10Mbps download	£1.01bn	£1.14bn	+13%
Option 2. 'Preferred' - 10Mbps download, 1Mbps upload and quality conditions	£1.27bn	£1.43bn	+12%
Option 3. - 20Mbps download, 2Mbps upload	£1.63bn	£1.81bn	+11%
Option 4. 'Maximum'- Superfast 30Mbps download, 6Mbps upload and 10Mbps CIR	£1.90bn	£2.17bn	+14%

6.6 Optimism bias and cost profile

Throughout this impact assessment, the costs provided by Ofcom and Analysys Mason have been used as a starting point. However, for our headline figures and modelling we have adjusted these costs based on the Treasury's green book guidance for optimism bias, utilising a non-standard infrastructure project as base. Optimism bias for non-standard infrastructure projects has an upper bound of 66% added on top of the original costs. This additional 66% is mitigated through a variety of factors and the more certain variables, such as a poor business plan or technology constraints, are mitigated, the lower the bias becomes.

In the modelling undertaken for the consultation different scenarios were allocated different levels of optimism bias based on the proportion of Long Range VDSL used in each technology mix. This is because LR-VDSL was still undergoing a trial and we could not be certain of how it would perform and the extent to which it would be used. Therefore the scenarios that make greater use of this technology had less mitigation and a higher optimism bias applied. We now understand that BT no longer intend to use this technology. However, as the bottom up cost modelling undertaken by Analysys Mason has not been repeated the costs will be understated for options that use LR-VDSL as alternative more expensive technologies have not been substituted in. Therefore the additional optimism bias has been retained to counter this under-estimate. This largely impacts the costs of Option 1 with little impact on the other options. Although Options 3 and 4 are more expensive and larger scale construction projects they use technologies that are largely tried and tested (and reflect the current BDUK rollout) so their optimism bias is at similar level to that for Option 2.

<u>Optimism Bias Added to Costs by Option</u>

	Optimism Bias Percentage
Option 1. 'Minimum' - 10Mbps download	55%
Option 2. 'Preferred' - 10Mbps download, 1Mbps upload and quality conditions	49%
Option 3. - 20Mbps download, 2Mbps upload	48%
Option 4. 'Maximum'- Superfast 30Mbps download, 6Mbps upload and 10Mbps CIR	48%

The cost profile takes into account ongoing costs and replacement costs over the life of the asset. The specific methodology used to estimate the costs of the project estimates the lifetime of the asset and takes into account running costs and initial purchase of these assets. The lifetime of each individual asset within the infrastructure is different i.e. Trenches may have a lifetime of 50 years whereas some elements may only have a lifetime of 6 years. However, the Analysys Mason model assumes all costs are upfront and incurred in year one. This is not realistic as you would expect the bulk of the costs to be spread out over an initial construction period. We have assumed this period to be 5 years and to follow a similar cost profile to that of the BDUK Superfast Programme. Because we are assuming total cost of the project is incurred in the first 5 years this is an upper bound for these years as you would expect that the costs would not reach their cumulative maximum until

2035 (the end of our appraisal period) due to some smaller running costs. As we have been unable to split out running costs and apportion them over the full appraisal period this cost profile is front-loaded, over-estimating the costs in the first 5 years. Given how the costs are discounted (whereby costs incurred later have less value in present value terms) this means the overall cost estimates will be slight overestimates.

The costs have been discounted over the period up to 2035, using a 3.5% discount rate, to provide present value estimates of the total cost under each option. The appraisal period has been chosen as up to 2035 for a number of reasons:

- to reflect the lifetime of the assets - most of the capital purchased will last at least 15 years, some longer;
- to provide a span of time over which benefits will be accrued - 15 years from implementation in 2020;
- to match the appraisal periods typically used for capital investments in telecoms, which are generally 15 to 20 years;
- for practical purposes, as this is the date which the DCMS broadband benefits model (outlined below) extends to.

<u>Total Cost of Each Option in Present Value Terms Including Optimism Bias (without cost threshold and with a threshold of £3,400)</u>

	Total Cost without a cost threshold (Present Value, 2017 prices)	**Total Cost with a £3,400 cost threshold (Present Value, 2017 prices)**
Option 1. 'Minimum' - 10Mbps download	£1.26bn	£0.82bn
Option 2. 'Preferred' - 10Mbps download, 1Mbps upload and quality conditions	£1.52bn	£1.02bn
Option 3. - 20Mbps download, 2Mbps upload	£1.94bn	£1.42bn
Option 4. 'Maximum'- Superfast 30Mbps download, 6Mbps upload and 10Mbps CIR	£2.26bn	£1.63bn

Total Cost of Option 2 in Present Value Terms Including Optimism Bias (with different cost thresholds)

	Total Cost (Present Value, 2017 prices)
Option 2 with £1,500 cost threshold	£0.81bn
Option 2 with £2,200 cost threshold	£0.88bn
Option 2 with £3,400 cost threshold	£1.02bn
Option 2 with £5,000 cost threshold	£1.26bn

7. Benefits

7.1 Benefits methodology

In 2013, DCMS commissioned a report into the economic, social and environmental impacts of faster broadband. The report was the product of a rigorous and detailed analysis, which drew on the best data available, by economic and social consultancy firm SQW in partnership with Cambridge Econometrics and Dr Pantelis Koutroumpis. The final published report, the UK Broadband Impact Study[72], describes the avenues through which economic, social, and environmental benefits accrue as a result of improved broadband.

To inform the report SQW developed a detailed econometric model to quantify benefits. As well as drawing on findings reported in the academic literature, the model developed for the study was informed by a review undertaken by Cambridge Econometrics of broadband impact studies previously carried out for local authorities and devolved administrations across the UK. The design of the model sought to expand on the best aspects of these previous approaches, while excluding some mooted routes to impact which appeared to be too speculative, or unsupported by the available evidence, in the study team's opinion. The report stated that the resulting analysis is considered "to be the most in-depth and rigorous forward-looking quantification of broadband impacts developed to date in the UK".

The underlying hypothesis for the model is that speed matters: faster broadband will enable businesses and individuals to change the way they do things. In order to capture the effect of continuing improvements in broadband speed over time, the model incorporates explicit links between the projected broadband speeds available, the projected speeds used, and their projected net impacts. For some impacts, it is the relative broadband speed (i.e. the speed available in an area compared with the national average) that is the key driver, rather than the absolute speed. Given that upstream speeds are important, as well as downstream speeds, (e.g. for cloud computing and video applications), this is reflected in the model by combining the two into a notional 'total speed'.

72 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/257006/UK_Broadband_Impact_Study_-_Impact_Report_-_Nov_2013_-_Final.pdf

A full list of the inputs and assumptions of the model are included in Annex A of the UK Broadband Impact Study[73]. The evidence behind the various "routes to impact" in the model, including the most important assumptions is set out in the section below.

On completion of the project the model was handed over to analysts in DCMS and has been used to model various public broadband interventions since. Whenever it is used it is updated with the latest data on actual broadband rollout to ensure that the counterfactual estimated in 2013 reflects how broadband rollout has actually developed over the preceding years. In late 2015 SQW were commissioned to carry out a more comprehensive update to the model, including extending the time period covered (out to 2035), building in more technologies and reviewing updates to the evidence base to ensure that the key assumptions still held. It is this updated model that has been used as the basis of the benefits calculations set out below.

Economic Benefits

The report models 5 'routes to impact' of the economic benefits: productivity growth of broadband using enterprises; safeguarding of local enterprise employment; teleworker productivity; labour force participation; and network construction impacts. By far the most significant of these is the productivity gains. The report states: "It is now widely accepted that the availability and adoption of affordable broadband plays an important role in increasing productivity in national economies – through, for example, supporting the development of new, more efficient, business models, enabling business process re-engineering to improve the efficiency and management of labour intensive jobs, and enabling increased international trade and collaborative innovation".

An illustrative example of how the benefits of improved broadband manifest is the increased capacity for teleworking. Not only does this have productivity benefits for firms such as through teleconferencing with clients, business partners, etc., but it also makes it easier people to work from home, bringing those otherwise unable into the job market. Working from home reduces inefficient travel related time, money, and stress, and enables people to set up and run their own businesses much more effectively, with access to the e-commerce market, for example. More detail on the economic benefits is available in the report.

Figure 1 gives an overview of how the UK Broadband Impact Study model works, and the benefits to the UK economy it measures. By looking at the availability of technologies and their speeds, the uplift in internet speeds can be compared to a baseline with no intervention. Both the absolute and relative speeds are modelled. The benefits from these speed changes in terms of productivity, safeguarding local enterprise, increased teleworking and increased access to the labour market for carers and the disabled are monetised.

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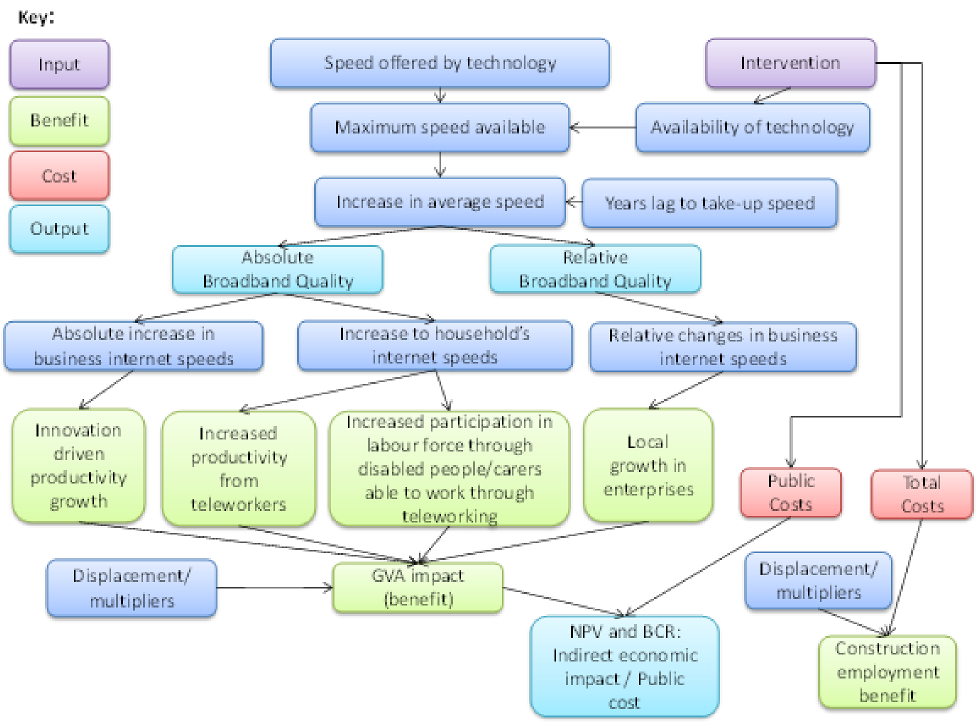
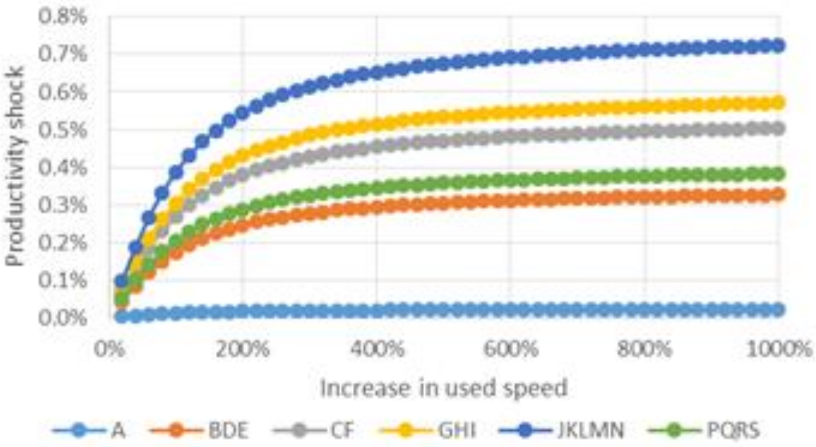
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/257006/UK_Broadband_Impact_Study_-_Impact_Report_-_Nov_2013_-_Final.pdf

Figure 1 Schematic of the UK Broadband Impact Study model



Innovation driven productivity growth – SQW conducted a wide ranging literature review. This provided evidence backing the widely accepted view that the availability and adoption of affordable broadband increases productivity of businesses. This is through a range of mechanisms, from developing more efficient business processes, increased international trade and collaborative innovation. The majority of the evidence shows the benefit from dial up to standard broadband, with less evidence in the jump to superfast, and even less on ultrafast. However, SQW updated their literature review ahead of updating the model in 2015, and found that the evidence still broadly supported their assumption. The key assumptions in this part of the model relate to the benefit of doubling internet speeds. SQW estimate that productivity grows on average by 0.3% when speeds double, but then scale this depending on the ICT dependency of the industry sector (by the standard ONS classifications). They also cap the factor, by using a logarithmic curve, so a large shift in speed does not have a disproportionate increase in productivity. Figure 2 shows the final factors used.

Figure 2 Productivity shock factors by business sector[74]



In estimating the productivity impacts of faster broadband the model also takes account of:

- *The distribution of businesses by geography, drawing on ONS data on the count of private sector local units and employment for each of the six broad industry groups, in four size bands and at a detailed level of geography, which is then mapped against density deciles (which divide UK Census output areas into deciles depending on their premise density).*
- *Lags in take up of newly available broadband speeds, assumed to depend on the size of the business with the smallest businesses taking up to 10 years to take up faster broadband.*
- *Lags associated with realising productivity improvements after taking up a faster broadband connection, with an assumption that it takes three years for the productivity shock associated with increases in speed to be fully realised.*

Safeguarding of local enterprise employment – SQW's review of literature found a complex relationship nationally with regards to local broadband availability. They found that for the smallest SMEs the adverse effects of being digitally disadvantaged would not be entirely replaced by the job creation in better connected areas. Therefore reducing the digital divide can suppress national displacement of jobs and have a net benefit by safeguarding local employment.

In developing estimates of these impacts, the model uses a concept of 'Relative Broadband Quality' (RBQ), which is the indicative speed available in each decile divided by the national average. The densely populated areas of the UK typically therefore have an RBQ of greater than 1.0, while the least dense deciles typically have an RBQ of less than 1.0, though the values change over time.

The model uses curves which estimate the annual growth of enterprises and employment in an area as a function of Relative Broadband Quality in that year. The shapes of these curves have been informed by an analysis of the differences between the years 2008 and 2012 in the number of business sites and employment in each density decile, using data from ONS. This analysis found no convincing growth trends across density deciles for 10+ employment size bands, but there was a modest positive trend for higher growth with increasing density for the count of 1 to 9 employment firms. Adjusting for the proportion of this trend that can be attributed to changes in RBQ, the curve

[74] Business sectors represent the UK Standard Industrial Classification (https://onsdigital.github.io/dp-classification-tools/standard-industrial-classification/ONS_SIC_hierarchy_view.html) The lowest impact (sector A) represents agriculture, forestry and fishing, whereas the sectors with the highest impact (sectors JKLMN) include sectors such as information and communication, financial services and professional, scientific and technical activities.

for the 1 to 9 employment size band results in annual growth rates of, for example, -0.05% at an RBQ of 0.5, and +0.03% at an RBQ of 1.5. The curves for 10+ employment size bands have been ‘zeroed out’, as no clear relationship was observed in the historic data. That is, the safeguarding employment impact is effectively only assumed to be relevant to the 1 to 9 employment size band.

Teleworker Productivity – SQW found evidence that a proportion of the time by teleworkers not having to commute is spent working, thus increasing their working hours and therefore productivity. There is also some evidence that teleworkers may also be more efficient, but SQW use their more conservative assumption around a proportion of additional time instead.

In estimating teleworker impacts the model takes account of:

- The proportion of employed people who are ‘telework-eligible’ varying by Standard Occupational Classification (averaging 48% of all employed people); the distribution of occupations by density decile, using census data; and estimates of the proportion of telework-eligible employees who do telework to some extent, by year – rising from 40% in 2008 to 72% in 2024. Of these, only the proportion employed in the private sector are assumed to contribute to a net GVA effect.
- A curve estimating the relationship between days per year teleworked and the average used household speed (including a saturation level), and estimates of the relative propensity to telework by density decile, derived from an analysis of census data on those working mainly at or from home.
- The average duration of a two-way commute, by density decile, using data from the census and from the National Travel Survey (44 to 78 minutes); the proportion of saved time used for work (we have assumed 60%, based on a previous Cisco survey); and the average GVA per hour worked.

Labour force participation – The ability to work from home will reduce barriers to carers and disabled people working, increasing participation in the labour force.

In estimating labour force participation impacts the model takes account of:

- The numbers of working age people who are economically inactive due to looking after the home or family members, by density decile; the proportion of these who would like a job; and proportion of these who would be telework-eligible.
- The number of unemployed disabled people, by density decile, and the proportion of these who would be telework eligible.
- Curves estimating the proportions of telework-eligible carers and unemployed disabled people gaining home-based employment, as functions of the average used household speed (including saturation levels).
- GVA per additional worker (assumed to be full-time for disabled people, and part-time for carers).

Construction effects - This reflects the induced economic benefits from undergoing a large scale infrastructure construction process, generating GVA and gross employment effects associated with this type of activity. However, in the final outputs from the model this activity is assumed to be 100% deadweight as the public funds would have been used elsewhere otherwise.

<u>Social Benefits</u>

In 2013 the UK Broadband Impact Study[75] surmised that "Beyond its economic impacts, broadband has, of course, become an integral part of modern life, affecting various aspects of our day-to-day activities as individuals, families and communities."

A more recent literature review on the social benefits of improved broadband was commissioned as part of the Superfast Broadband Programme evaluation planned to be published later in 2018. Unless otherwise stated the findings are from that study. We have not attempted to quantify social benefits due to the inherent difficulties in doing this.

Reduction in Travel

A number of sources highlight the benefits for many (especially those in rural/remote areas) through a reduction in the need to travel. Examples given include areas such as e-government (filing taxes and transacting other business with local and national governments[76], online shopping and employment[77]. The rise of teleworking (working from home) gives rise to economic benefits as described above, it also has social benefits related to reduced travelling.

The benefits from avoiding travel can be measured in two ways – firstly through the monetary savings that can be made by not travelling (e.g. on petrol, parking, other costs), and secondly through being able to use the time that would have been spent travelling on leisure or another purpose entirely. Ashmore, Farrington and Skerratt (2015)[78] note that the ability to get banking and other shopping activities organised online meant that the participants they spoke to were afforded "*greater control over how they planned their physical shopping excursions*".

Access to Education

The internet has becomes increasingly central to education but children with unreliable internet at home are unable to access resources in the same way as other classmates : "*Glow [online platform used by schools as a teaching resource] – she can't get onto all of it…she sits there for hours and waits for it and that's pretty sad*"[79].

Improved broadband is seen as making the provision of education and remote training more successful. Citing the increasing availability of the option to gain formal qualifications entirely remotely through the use of video conferencing for lectures and tutorials, J Meador (2016)[80] notes

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https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/85961/UK_Broadband_Impact_Study_-_Literature_Review_-_Final_-_February_2013.pdf

76 Van de Wee, M., S. Verbrugge, B Sadowski, M. Driesse & M. Pickavet (2015): "*Identifying and quantifying the indirect benefits of broadband networks for e-government and e-business: A bottom-up approach*" in Telecommunications Policy (39: 3-4) pp176-191. Available at: http://www.sciencedirect.com/science/article/pii/S030859611300205X (cited 28/07/17).

77 Philip, L., C. Cottrill, J Farrington, F. Williams & F Ashmore (2017): "The Digital Divide: Patterns, policy and scenarios for connecting the 'final few' in rural communities across Great Britain" in Journal of Rural Studies, 2017 pp1-13. https://www.sciencedirect.com/science/article/pii/S0743016716306799

78 Philip, L., C. Cottrill, J Farrington, F. Williams & F Ashmore (2017): "The Digital Divide: Patterns, policy and scenarios for connecting the 'final few' in rural communities across Great Britain" in Journal of Rural Studies, 2017 pp1-13. https://www.sciencedirect.com/science/article/pii/S0743016716306799

79 Townsend, L., C. Wallace & G. Fairhurst (2015): "*'Stuck out here': the critical role of Broadband for remote rural places*" in Scottish Geographical Journal (131: 3-4) pp171-180. Available at: http://dx.doi.org/10.1080/14702541.2014.978807 (cited 28/07/17).

80 Meador, E. (2016): "Superfast broadband in Scotland: Implications for Dumfries and Galloway", available at: https://www.researchgate.net/profile/John_Meador/publication/308163239_Policy_Briefing_10_Superfast_B

that the provision of superfast broadband to those areas in Dumfries and Galloway currently without it would allow residents to participate in formal and informal distance education, raising educational attainment in an area of Scotland where the proportion with tertiary education is lower than the national (Scottish) average.

Access to Health and Social Services

There is a large potential for remote services to improve health and social services. Telemedicine applications that enable remote screening, diagnosis, treatment and monitoring allow people to receive quality care in the communities in which they work and live.

There are challenges associated with fully realising the potential of telemedicine benefits. More vulnerable people who might benefit most from telemedicine may be least likely to have interest in using the internet or taking up better broadband should it become available. Additionally, the literature review from 2013[81] notes that this sort of benefit relies on local health services being structured to provide telemedicine, which was not the case at that time, and seems unlikely to be the case now. However, in recent years remote GP services accessed through video-conferencing have started to reach the mainstream market.

Consumer access benefits

Another similar benefit relates to savings more generally through increased availability of online shopping. This operates at both ends; consumers will be better able to use online shopping platforms to shop around and find cheaper goods and services, saving money that can be used elsewhere, while rural-based businesses may be able to offer more competitive prices through a reduction in the business costs of physical isolation[82].

More broadly, those without good-quality broadband are unable to reliably access some online services that others take for granted, as demonstrated by the example of Glow, the online teaching resource given above. The UK government assumes "digital by default" in the provision of public services. Currently all public services can be accessed with a 2Mbps download speed, but should the bandwidth requirements of government websites increase (in line with the general growth in size of websites), then faster broadband may become necessary for universal reliable access to public services. A number of articles cite a longer-term concern that the withdrawal of commercial and public organisations from physical locations to being solely available online will be damaging to non-users of the internet, with the suggestion that an inability to access online services may "generate a new dimension of social exclusion that transcends conventional 'causes' of disadvantage such as low income"[83]. A report by Deloitte Access Economics and the Australian Government from 2013[84]

roadband_in_Scotland_Implications_for_Dumfries_and_Galloway/links/57dbad6808ae5292a376bd14.pdf (cited 28/07/17)

81 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/85961/UK_Broadband_Impact_Study_-_Literature_Review_-_Final_-_February_2013.pdf

82 Philip, L., C. Cottrill, J Farrington, F. Williams & F Ashmore (2017): "The Digital Divide: Patterns, policy and scenarios for connecting the 'final few' in rural communities across Great Britain" in Journal of Rural Studies, 2017 pp1-13. https://www.sciencedirect.com/science/article/pii/S0743016716306799

83 Philip, L., C. Cottrill, J Farrington, F. Williams & F Ashmore (2017): "The Digital Divide: Patterns, policy and scenarios for connecting the 'final few' in rural communities across Great Britain" in Journal of Rural Studies, 2017 pp1-13. https://www.sciencedirect.com/science/article/pii/S0743016716306799

84 Commonwealth of Australia & Deloitte Access Economics (2013): "Benefits of high-speed broadband for Australian Households", available at:

outlines that "*there is some evidence that these greater impacts [of good-quality broadband] are where households face difficult circumstances, such as needing to find employment, move residence or where additional education is of significant benefit*".

Access to Employment

The previously published literature review from 2013 found that "The use of broadband internet at home may also play a role in opening up job opportunities for people who would otherwise find it difficult to participate in the labour market. In a recent survey of over 1,000 working age people not currently employed, a study for the Australian Government found that 76% of people with family or caring commitments, and 70% of people with a disability would take up a teleworking employment opportunity, if it was available (Colmar Brunton Research and Deloitte Access Economics 2012). These groups indicated a preference to work from home the majority of the week, but still have some connectedness to the office to overcome issues of isolation.**"**

Wellbeing

There are both positive and negative benefits of better broadband for personal and community wellbeing.

Improved mental well-being is seen as a key benefit of good-quality broadband, whether through enhanced contact with distant family members using video conferencing [85], reduction in the need to travel for work [86], or a more general feeling of control over one's affairs – as Ashmore, Farrington and Skerratt (2015)[87] suggest, the "*contribution to household life can be linked to a sense of personal well-being and empowerment, and enablement of personal skill building and self-sufficiency, thereby increasing perceived resilience despite being in a geographic location that may lack access to physical services.*"

The same paper also suggests that broadband allows people to become more active in their local community by making it easier to communicate with each other and be involved with local groups. The continuous (and improved) connectivity that the Universal Service Obligation can provide means that people in rural communities can talk to each other and keep on top of community news throughout the day more reliably, efficiently and easily. They report that good-quality broadband can support "*the communication of local initiatives, and generate a higher level of local activity.*"

The negative impacts outlined in the literature relate to increased isolation and loneliness among internet users through reducing personal contact and internet addiction. In a paper reviewing literature on the internet and social isolation, O. Lelkes (2013)[88], notes that "*Internet can be addictive and can bring about an uncontrollable compulsive urge. One of the dangerous effects of*

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https://www2.deloitte.com/content/dam/Deloitte/au/Documents/finance/deloitte-au-fas-benefits-highspeed-broadband-v2-240914.pdf (cited 26/07/17)

[85] Townsend, L., C. Wallace & G. Fairhurst (2015): "*'Stuck out here': the critical role of Broadband for remote rural places*" in Scottish Geographical Journal (131: 3-4) pp171-180. Available at: http://dx.doi.org/10.1080/14702541.2014.978807 (cited 28/07/17)

[86] Commonwealth of Australia & Deloitte Access Economics (2013): "Benefits of high-speed broadband for Australian Households", available at: https://www2.deloitte.com/content/dam/Deloitte/au/Documents/finance/deloitte-au-fas-benefits-highspeed-broadband-v2-240914.pdf (cited 26/07/17)

[87] Ashmore, F., J Farrington & S. Skerratt (2015): "*Superfast Broadband and Rural Community Resilience: Examining the rural need for speed*" in Scottish Geographical Journal (131: 3-4) pp265-278

[88] Lelkes, O. (2013). "Happier and less isolated: Internet use in old age" in Journal of Poverty and Social Justice (21:1) pp33-46. Available at: http://www.euro.centre.org/data/1378457381_6868.pdf (cited 28/07/17)

internet addiction is that it can take the form of replacing face-to-face interaction time with emails and social media websites which may amounts individuals losing their self-identity". However, the paper concludes that overall the net impact of internet connectivity is positive, providing more opportunities for connection than isolation, especially for older people.

Community resilience

A number of academic sources use the framework of "enhancing resilience" as a measure of the impacts of better broadband. In the literature this operates mostly within a rural context, where community resilience is highlighted as a particular issue. Ashmore, Farrington & Skerratt (2015) describe resilience as:

"Social–ecological resilience builds upon this understanding to represent the ability of a community to withstand shocks due to external, ecological factors (Adger 2000). In relation to rural areas, shocks, or changes, can include depopulation, a loss of, or a disinclination to develop, public services for small populations and demographic ageing (see Delfmann et al. 2014), which require individuals and communities to be able to adapt and adopt new practices (i.e. be resilient) to address such changes to their community structure and livelihood"

Recent papers define a framework for assessing the impact of better broadband on individual and community resilience. Heesen, Farrington & Skerratt (2013)[89] identify the impact on technological engagement (for instance through improving unreliable internet connections), the ability to live and work in a rural setting (the use of superfast in maintaining a rural life), and the capability for the local community to act together as key parts of community resilience that could be affected by a Universal Service Obligation.

Environmental Impacts

The UK Broadband Impact Report identified three routes to environmental saving as a result of improved broadband: the effect of reduced commuting as teleworking becomes more viable, the fall in business travel due to similar reasons, and the reduction in energy consumption as cloud storage becomes more viable. Environmental benefits are not included in the quantified benefits below.

Ongoing revenue

A direct benefit to industry that is not included as part of the model is the ongoing revenue from the customer. Once a premise is able to receive the broadband connection, they would still be required to pay for the retail service of their internet provider. However, there are two key issues to consider when estimating the value of this revenue - the change in service as a result of the USO and the impact of retail competition. Retail broadband prices depend to some extent on the available speed, but do not increase continuously with speed. Broadly, currently there is one price for non-broadband internet, another for speed between <1Mbps and 24Mbps and higher prices for superfast. Industry would only see an increase in their revenue if a premises' speed jumped between these boundaries so should the USO only lift speeds within the 1 to 24 Mbps bracket it would not enable them to recoup additional revenue. Retail competition further complicates this assessment as the provider that makes the initial connection may not benefit from any increased revenue if the consumer subsequently uses another firm as their service provider.

[89] Heesen, F., J. Farrington & S. Skerratt (2013): "Analysing the role of superfast broadband in enhancing rural community resilience", available at: http://aura.abdn.ac.uk/bitstream/handle/2164/4002/FHeesen_ESRS_Analysing_sfbb_in_enhancing_rural_community_resilience_ShortPaper_ESRS2013.pdf?sequence=1 (cited 28/07/17)

In reality, some premises will have superfast speeds made available as a result of the USO rollout, even under the 10Mbps options, because of their proximity to parts of the upgraded infrastructure. As some of these premises may take upgraded services there will be some revenue benefits to industry. Take-up of Superfast broadband where available is approximately 40%[90]. However, given the uncertainties in how the USO will be implemented, estimating the proportion of premises provided with access to Superfast broadband would be largely speculative at this stage. Therefore revenue gains have been excluded from this cost benefit analysis as a conservative assumption.

7.2 Modelled benefit results

Overview of the benefits model output:

The tables below set out the discounted benefits in GVA terms, both with and without reasonable cost thresholds which are generated by the benefits model set out above. As with the costs the benefits have been discounted over the period up to 2035 (which covers a 15 year period from implementation in 2020), using a 3.5% discount rate, to provide present value estimates of the total GVA benefits under each option.

Total GVA Benefits of Each Option in Present Value Terms Including Optimism Bias (without cost threshold and with a threshold of £3,400)

	Total Benefit without a cost threshold (Present Value, 2017 prices)	**Total Benefit with a £3,400 cost threshold (Present Value, 2017 prices)**
Option 1. 'Minimum' - 10Mbps download	£2.90bn	£2.86bn
Option 2. 'Preferred' - 10Mbps download, 1Mbps upload and quality conditions	£3.57bn	£3.51bn
Option 3. - 20Mbps download, 2Mbps upload	£5.17bn	£5.10bn
Option 4. 'Maximum'- Superfast 30Mbps download, 6Mbps upload and 10Mbps CIR	£5.55bn	£5.51bn

[90] Broadband Delivery UK: Table of Local Broadband Projects https://www.gov.uk/guidance/broadband-delivery-uk

Total GVA Benefits of Option 2 in Present Value Terms Including Optimism Bias (with different cost thresholds)

	Total Benefit (Present Value, 2017 prices)
Option 2 with £1,500 cost threshold	£3.42bn
Option 2 with £2,200 cost threshold	£3.45bn
Option 2 with £3,400 cost threshold	£3.51bn
Option 2 with £5,000 cost threshold	£3.56bn

The Net Present Value (up to 2035) and Benefit Cost Ratio of each option is set out in the tables below.

Net Present Value (NPV) and Benefit Cost Ratio (BCR) of Each Option (without cost threshold and with a threshold of £3,400)

	NPV without a cost threshold (2017 prices)	**NPV with a £3,400 cost threshold (2017 prices)**	**BCR without a cost threshold**	**BCR with a £3,400 cost threshold**
Option 1. 'Minimum' - 10Mbps download	£1.64bn	£2.04bn	2.3	3.5
Option 2. 'Preferred' - 10Mbps download, 1Mbps upload and quality conditions	£2.04bn	£2.49bn	2.3	3.4
Option 3. - 20Mbps download, 2Mbps upload	£3.23bn	£3.68bn	2.7	3.6
Option 4. 'Maximum'- Superfast 30Mbps download, 6Mbps upload and 10Mbps CIR	£3.29bn	£3.88bn	2.5	3.4

Net Present Value (NPV) and Benefit Cost Ratio (BCR) of Option 2 (with different cost thresholds)

	NPV (2017 prices)	BCR with different cost thresholds
Option 2 with £1,500 cost threshold	£2.61bn	4.2
Option 2 with £2,200 cost threshold	£2.67bn	3.9
Option 2 with £3,400 cost threshold	£2.49bn	3.4
Option 2 with £5,000 cost threshold	£2.31bn	2.8

The costs are assumed to be incurred in the first 5 years as the infrastructure is being constructed and then the benefits accrue slowly over time. This is due firstly to the lag between constructing the networks and firms connecting to them, and then further into the future the benefits increase as firms and individuals adapt their behaviour to the new technology and achieve further productivity gains. By the end of the appraisal period there is a positive NPV and BCR for all options.

The NPVs and benefit cost ratios are higher for all options when a cost threshold is implemented, reflecting the high costs with connecting the final few premises. Between the four options the BCRs are all very similar once the cost threshold is applied - they vary from 3.4 to 3.6. This shows that all options deliver a positive outcome and deliver value for money but does not point towards one being significantly better value for money than another. Given the assumptions that have been made and the uncertainties around both the costs and benefits these results are within a small margin of error of each other. Option 3 has the highest BCR at 3.6, followed by Option 1 with 3.5 and Options 2 and 4 with 3.4. However, there are some specific issues with delivering each option which influence the choice:

- Option 1 is deliverable but does not provide upload speeds and quality standards that enable users (including small business users) to carry out common tasks such as video conferencing and sharing large images and video files. The influence of these factors is not fully reflected in the benefits modelling (which is driven by download speeds), which means that Option 1 appears more favourable compared to Option 2 than it would in reality.

- Options 3 and 4 give an improved level of connectivity, but come with much higher costs. Higher costs will impose a greater burden on industry who will be required to contribute to an industry cost sharing fund, meaning this will lead to a greater degree of market distortion. They would also take longer to deliver, which is particularly pertinent, given how long households and businesses in USO areas have waited to see connectivity improvements. It would also not be proportionate.

Therefore, Option 2, which delivers an NPV of £2.49bn with a BCR of 3.4 (with a £3,400 cost threshold) is the chosen option. It delivers a safety-net for broadband provision which strikes a proportionate balance between the benefit to those with poor broadband provision, the costs of delivery, how long it would take to deliver, and the need to minimise market distortion. The provision for Government to direct Ofcom to review the minimum speed and other quality parameters in the future as consumer needs evolve (as set out on page 8) means that should a higher specification solution become necessary and proportionate it could be adjusted to meet this. As such, the option is also future-proofed.

Ofcom has advised that a 10Mbps specification (with quality parameters) is sufficient to meet the needs of a typical household. And while it will be necessary to keep the minimum specification under review, it is not appropriate to set it higher now, even if this does create the potential for efficiency savings in the long term, as this will go beyond Article 4 of the Universal Service Directive which requires that "the connection provided shall be capable of supporting voice, facsimile and data communications at data rates that are sufficient to permit functional Internet access, taking into account prevailing technologies used by the majority of subscribers and technological feasibility."

Having determined that a 20Mbps or 30Mbps USO was not justified at this time, on the basis that the USO is supposed to act as a safety-net, we then considered a range of different cost thresholds for Option 2. Only once we had determined the specification for the USO was it appropriate to consider an appropriate cost threshold - it was therefore not appropriate for us to consider a range of cost thresholds for the 20Mbps or 30Mbps scenarios as these were out of scope.

When considering the different cost thresholds for Option 2 the BCR is positive for all and increases the lower the threshold. A high threshold of £5,000 which would mean a greater number of premises connected has a BCR of 2.8 while a low threshold of £1,500 that would mean fewer premises connected has a BCR of 4.2. As set out earlier, a £3,400 threshold is preferred by government as one that delivers significant coverage whilst imposing proportionate costs. The cost benefit analysis suggests that better value for money could be delivered by a lower threshold. This reflects the fact that per premise costs continually increase the more premises are in scope but the benefits are fairly uniform. However, such a lower threshold would leave more and more premises out of scope, meaning that the policy does not deliver its primary function of acting as a safety-net for those the market will not provide for. With a £3,400 cost threshold only around 50,000 premises are left out of scope, and they have the potential ability to connect if they are willing to pay the difference in costs. For a £1,500 cost threshold around 120,000 premises are left out of scope, and those at the higher end of the distribution would need to pay more to connect if they are willing to pay the difference in costs. This higher level of premises left unconnected is not considered sufficient coverage for a policy that is designed to act as a safety net.

A higher threshold could capture more premises whilst still delivering a positive BCR but, as noted above, the choice needs to take into account not just the value for money considerations but also the degree of market distortion and the requirements of the regulatory framework. Given that the BCR is still strong at 3.4, that this is only a partial analysis of the benefits which does not include consumer or wider social benefits, and imposes proportionate costs while minimising market distortion, a cost threshold of £3,400 for Option 2 is considered the preferred option.

The Broadband Stakeholder Group commissioned Plum Consulting to undertake a report examining The Impacts of a broadband USO in the UK[91]. Their report found that the optimum point to set the reasonable cost threshold was between £1,500-3,000. The relatively large variance was due to the lack of evidence around the economic benefits delivered to each premise. Despite the difference between their recommendation and the Government's proposed cost threshold of £3,400, they found no course to object, particularly as their research still demonstrated a net position benefit to the UK for such a cost threshold.

7.3 Direct vs Indirect Benefits

Guidance from the Regulatory Policy Committee Methodology Sub-Group on whether these quantifiable benefits are direct or indirect has concluded that not all of the modelled benefits are direct. The sub-group decided that the only direct impact of improved broadband would be time savings in undertaking existing business activities by broadband-using firms. The further productivity gains to the firm through innovation or changing business models were considered to be indirect. Therefore, although total benefits are included in the overall NPV calculation, only those we can identify as being direct feed into the EANDCB and OI3O calculations.

Separately quantifying direct and indirect productivity benefits is difficult when no measure of productivity reports them separately. One approach would be to assume benefits realised earlier are more likely to come from initial efficiency gains, and are therefore direct, and benefits realised later are more likely to relate to innovation and are therefore indirect. The 2013 SQW Broadband Impact Study[92] assumed that the majority of productivity gains would come about through innovation and changing business models and modelled a three year lag between infrastructure improvements and productivity gains. However, more recent evidence from the evaluation of the Superfast Broadband Programme found that workplaces in areas receiving superfast broadband benefited from increases in turnover per worker of an average 2.1% over three years, with the benefits accruing rapidly in the first two years. This suggests that the direct benefits of improved broadband are quite large and are realised earlier than was originally modelled. This could reflect the existence of "off the shelf" solutions that are readily available for businesses and can be implemented as soon as they have a suitable internet connection, such as cloud computing services or electronic retail / delivery platforms, or more efficient use of services they had previously adopted but their prior connection was not good enough for optimal use. It is too early to measure the productivity gains from the superfast programme over longer time periods.

The outputs from the broadband benefits model used for this IA do not allow us to disaggregate these direct and indirect categories of impact. Therefore, to estimate direct impacts we have drawn on previous research evaluating the BDUK connection voucher scheme where companies report how access to broadband has affected their companies. Using this paper we have estimated the average amount of productivity benefit from direct sources (i.e. not incorporating behavioural change) to be around 70%, and applied this proportion to the outputs generated by the broadband benefits model.

The estimates are derived from the 'Connection voucher scheme impact and benefit study'[93] . This paper is an evaluation of the connection voucher scheme which helped many thousands of businesses and third sector organisations to reap the benefits of an improved broadband connection

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91 http://www.broadbanduk.org/wp-content/uploads/2017/05/Plum-May-2017-BSG-Impact-of-a-broadband-USO-in-the-UK-FINAL.pdf

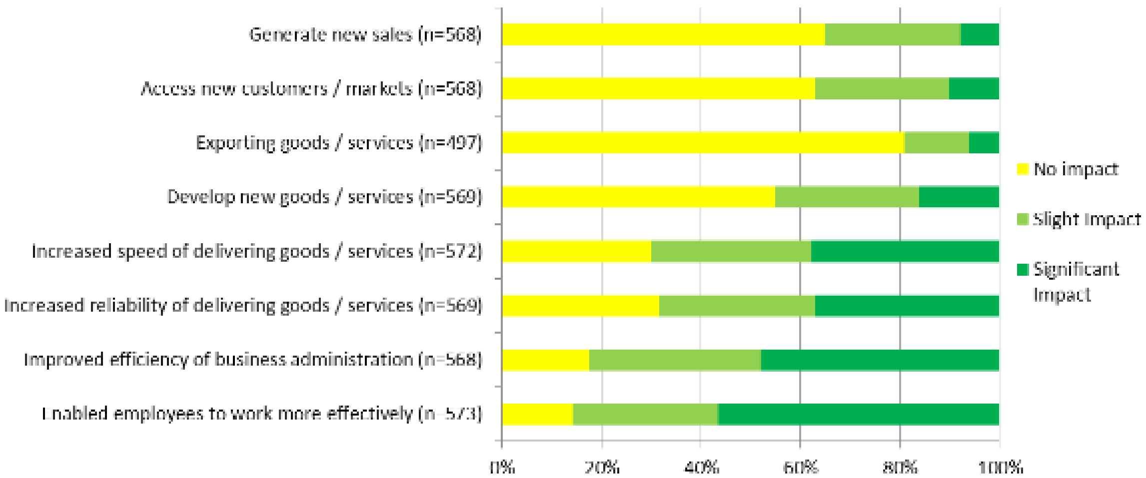
92 https://www.gov.uk/government/publications/uk-broadband-impact-study--2

93 https://www.gov.uk/government/publications/broadband-connection-voucher-scheme-impact-and-benefits-study

by subsidising the upfront capital costs of getting a connection to their premises. This evaluation looks at the impacts and benefits for firms of this greater access to broadband and can be considered a reasonable proxy for the benefits firms may experience through being connected to broadband because of the USO.

The research found that firms saw a significant benefit from this scheme with one in four firms employing an extra full time member of staff and each making an average of £1,300 more profit per annum, through being more efficient and effective, and providing more reliable and faster delivery of goods and services. A key piece of evidence from the research is the extent to which firms reported impacts that could lead to growth and productivity improvements, as set out below in figure 2 :

Figure 2: To what extent has upgrading your broadband connection resulted in the following impacts.



Using the results from figure 2, we considered the four bottom categories to be direct impacts on business as they most closely matched to time and efficiency savings of previous activities. These categories are: Increased speed of delivering goods/service, increased reliability of delivering goods/services, improved efficiency of business administration and enabled employees to work more effectively. The top four categories we consider to be more indirect: generate new sales, access new customers / markets, exporting goods / services, develop new goods / services. Based on all the self-reported significant impacts 82% came from the four direct categories and of the slight impacts 57% came from the four direct categories. Overall 69.7% of the impacts reported related to the direct categories and we have used this as a central estimate of the proportion of productivity benefits that can be considered direct.

The benefits model for the USO separates economic impacts into four categories and of these only one category seems economically likely to involve direct effects. That is the enterprise productivity growth category. Therefore, to breakdown direct and indirect benefits we took the 69.7% figure we assume to represent the proportion of direct effects to indirect effects within the above categories and applied this to the benefits figures for enterprise productivity growth. Overall this means that direct benefits account for between 40% and 42% of the total modelled benefits, depending on the option.

This estimate of direct benefits has been made using the best available evidence we have at this point in time but does require making a number of assumptions and has a number of weaknesses. Most notably it is likely that survey respondents for the connection scheme evaluation would underestimate the potential longer term productivity gains that their broadband connection would provide. Therefore they are likely to have under-reported these benefits, making the proportion of such indirect benefits lower than would actually be the case. This would suggest we have overestimated the direct benefits as a proportion of total modelled benefits. Also, given the evaluation is from one specific program it is possible these results will not be completely replicated in the USO, as the scope and size of the investment is not directly comparable. However, the findings of the more recent evaluation work, as outlined above, suggest that the immediate and direct impacts are greater than had been previously estimated, with a shorter time lag. This would suggest the model as a whole underestimates such impacts. Ultimately, it will not be possible to say for certain how the impacts are disaggregated until many years into the future when the full effects are completely unravelled. However, this is the best estimate possible based on the evidence available at this point in time.

The Regulatory Policy Committee also noted that as the model estimates an impact in Gross Value Added terms this will include both compensation of employees and company profits. For the purposes of the EANDCB only additional profit should be considered a benefit to business. The model doesn't disaggregate outputs in a way that enables such a distinction to be made so instead we have looked to identify a ratio of profit to GVA that can be applied to the outputs. The UK Economic Accounts published by the Office for National Statistics includes a disaggregation of GDP by category of income which reflects this relationship at the level of the whole economy[94]. For the most recent year for which data is available (2016) it estimates compensation of employees as 49.4% of GDP and gross operating surplus as 31.9% of GDP. Therefore we estimate gross operating surplus as 39.2% of GVA (gross operating surplus divided by the sum of gross operating surplus and compensation of employees).

Gross operating surplus (GOS) reflects the profit from production of goods and services, excluding depreciation. GOS is split in the accounts into corporations and "other"(including e.g. General government GOS). However, compensation of employees is not split in the same way. Ideally we would compare corporations GOS to corporations compensation of employees as this would more directly represent the business sector. However, in the absence of this breakdown we have used the economy-wide proportions.

The stages in the EANDCB calculation are set out below.

	£m (2017 PV)	**Source / calculation**
Total Cost £m	1020 (All costs are direct)	Output from Analysys Mason costing model, adjusted for updated number of premises in scope, effect of cost threshold and optimism bias

[94] ONS, United Kingdom Economic Accounts Q3 2017, Table 1.14, https://www.ons.gov.uk/file?uri=/economy/grossdomesticproductgdp/datasets/unitedkingdomeconomicaccounts/current/unitedkingdomeconomicaccounts2017q3.pdf

Total GVA Benefits £m	3510 (Direct and indirect)	Output from broadband benefits model
GVA benefits associated with Enterprise Productivity Growth £m	1987 (Direct and indirect)	Output from broadband benefits model
Enterprise productivity growth GVA benefits associated with direct time and efficiency savings £m	1385 (Direct and indirect)	Adjustment for direct time and efficiency savings at 69.7% of benefits as sourced from connection voucher scheme impact and benefit study
Enterprise productivity growth profits associated with direct time and efficiency savings £m	543 (Direct)	Adjustment for profits as a proportion of GVA at 39.2% of benefits as sourced from national accounts

This results in a final EANDCB for Option 2 of £30.5m.

8. SAMBA

This policy is designed to provide universal affordable access to a minimum level of broadband connectivity (defined as 10Mbps) to premises that are currently unable to access this speed. The universal nature of this intervention means it is expected to provide productivity and time saving benefits to all sizes of business including small and micro businesses. Given that the USO will largely benefit more remote and difficult to reach areas it is more likely that the businesses benefitting will be small rather than large. However, given the structural workings of our benefits model we are unable to quantify what level of benefits will directly affect small and micro businesses.

The obligation to deliver the USO will be borne by a broadband provider (or providers) who are designated by Ofcom as the Universal Service Provider(s). USPs tend to be the providers with the most extensive networks, as these are most likely to be able to extend their networks at the least cost, such as BT. Responses to the consultation indicated that there was market interest from a number of operators in being considered as regional USPs. Ofcom will be responsible for the process of designating USPs.

The USP(s) may be able to receive funding to compensate them for any net cost burden associated with delivering the USO from an industry fund. Where Ofcom determines that the USO imposes an unfair burden on a USP it can establish an industry fund to compensate the USP. Ofcom will decide who should contribute to the fund and how it should be administered, and would be determined by Ofcom after a separate consultation. Any impact on small and micro firms would be assessed at that stage.

9. Competition

The USO has the potential to create several distortions to the current operation of the broadband market at both wholesale and retail levels, some of which flow from the specification for the USO, and some from how funding the USO is implemented. While policy decisions relating to the design of the USO fall to government, the design of any industry cost sharing arrangement will be determined by Ofcom following public consultation as part of their implementation once the specification has been set by government in secondary legislation.

Ofcom's technical advice document provided a discussion of market distortions which were raised as part of their call for inputs and potential mitigations. This is summarised below but can be found in more detail in section 10 of their technical advice to Government[95].

Issue	Mitigation
Diminished incentives for the designated provider to invest in network upgrades in potentially commercial areas as they would have a guaranteed return in USO designated areas.	Using a net cost calculation to determine the contribution of any USO fund to the specific investment. In areas where the provider may make a commercial return this would limit (or remove entirely) the ultimate contribution made by such a fund.
Risk of the USO provider "overbuilding" where existing networks exist, or are planned to be built in the near future, using USO designated funds.	Limiting eligibility to those premises where there is no network capable of offering the USO technical specification, and requiring the USO provider to take into other account the availability of other networks.
Crowding out potential private sector investment in broadband infrastructure by third parties given the risk that a provider could use USO funds to deploy at a lower private cost (given the costs are in part covered by USO funds).	It may be possible to design the eligibility status to take into account existing investment plans or potential for future investment. It would also be necessary to require the USO provider to make its own commercial investment in USO infrastructure, in order to avoid the provider deploying at a lower private cost than on the rest of its network. An alternative approach would be to set out a clear timetable for USO implementation within an area, providing a period for alternative investors to extend coverage into the area and remove the need for a USO.
Competitive distortions in the retail market, for example through a marketing advantage in being able to offer its services to every premise in the country, or alternatively through market power that allows the provider to set higher prices to USO customers.	Any marketing advantage could be included as part of a potential net cost calculation to determine the contribution of a USO fund to investment. Other abuses of market power could be addressed using uniform pricing requirements or passive and active wholesale

95 Ofcom (2016), "Achieving decent broadband connectivity for everyone: Technical advice to UK government on broadband universal service" https://www.ofcom.org.uk/__data/assets/pdf_file/0028/95581/final-report.pdf

	access requirements, which would provide for effective competition at the wholesale and retail levels.
Impact on providers of alternative technologies that do not meet the USO specification.	The higher the USO specification, the greater the likelihood of overbuild of broadband connectivity which is below the specification. For example, satellite or fixed wireless networks may be available to an area but be unable to meet the USO specification (and indeed the existing Openreach copper network would be subject to overbuild by the designated provider).

In the light of Ofcom's advice in our consultation we set out a number of proposals that would play a part in minimising market distortion to the extent that this was possible through the design of the USO. To help minimise the risk of overbuild and market distortion, and the imposition of costs on industry that might divert market investment and/or lead to disproportionate increases in consumer prices, we proposed that only premises who do not have, or are unlikely to have, a connection which meets the USO specification through commercial or publicly funded roll outs, should be eligible to be connected, and that the connections will be subject to a reasonable cost threshold. We sought views on whether the measures proposed sufficiently minimised the risk of market distortion. A range of views were expressed on this point but with most welcoming the targeted nature of the intervention aimed at addressing areas of market failure.

It is difficult to assess the impact that this intervention will have on consumer prices at this stage as it will depend on a number of factors: the size of the USO footprint when the USO is implemented which will depend on the extent of publicly funded and commercial broadband roll out that takes place by then; the level of demand for USO connections - some consumers may not choose to be connected, and for the premises above the cost threshold the willingness of consumers to pay any excess costs is uncertain; who the USP(s) will be and the technologies that will be used to deliver them - USP designation will be a matter for Ofcom; who will be asked to contribute towards the cost of the industry fund and whether they will pass on some or all of their cost contribution to consumers.

10. Rural Impacts vs Urban Impacts

Ofcom provided data regarding the rural - urban split for premises in scope for each option. This data reinforces the fact that the measures set out in the impact assessment are pro-rural, reducing the digital divide through predominantly targeting rural areas.

Premises in Scope by Rurality in the UK, May 17

		Option 1	Option 2	Option 3	Option 4
UK	Rurality	% Premises	% Premises	% Premises	% Premises
	Total	3.20%	3.70%	4.70%	9.10%
	Urban	1.0%	1.5%	2.50%	5.20%
	Rural	16.9%	17.3%	18.30%	33.70%

Source: Ofcom analysis of operator data, May 2017

11. EANDCB, Business NPV and Total NPV:

Option (with a £3,400 cost threshold)	**EANDCB [£m]**	**Business NPV [£m]** (Does not take into account indirect benefits to business)	**Total NPV [£m]** (For the USO all monetised costs and benefits are to business, so this incorporates direct and indirect benefits and costs to business)
1	**23.8**	**-373**	**2040**
2	**30.5**	**-477**	**2490**
3	**37.5**	**-587**	**3680**
4	**46.6**	**-730**	**3880**

Technology Annex

The options set out in the impact assessment specify the quality of broadband connection that must be provided but do not specify the technology that would be used to provide it. The costs model anticipates that the USP will use the lowest cost technology that could provide the relevant quality of broadband connection.

However, some technologies are expected to be ruled out based on their current capabilities. Ofcom's advice was that a wide range of current technologies can meet the proposed USO specification - fixed line broadband (notably FTTP, FTTC), fixed wireless, and mobile technologies. Based on its current capabilities however, particularly on latency, satellite could only be used to provide the connection specified for Option 1. There may be technology developments and alternative solutions in the future which, if they meet our proposed specification, could also be deployed to provide a USO connection.

Fixed line broadband

- Fibre to the Cabinet (FTTC);
- Fibre to the Remote Node (FTTRN);
- Cable (hybrid fibre coaxial)
- Fibre to the Premise (FTTP);

Broadband over a fixed line requires a continuous wired connection from the telephone exchange to the premise. Traditionally, internet has been delivered over the copper phone line, which limits the potential speed of the internet as data can only travel so fast down a copper line. Similarly, the further away the premise from the central exchange, i.e. the more wire the data has to travel along, the slower the connection. The replacement of copper with fibre in the connection enables higher speeds for the consumer.

Installing fibre optic cable connections to every premise (FTTP) is extremely expensive, and a common method of delivering higher broadband speeds is to install fibre optic cable up to a certain point along the copper telephone network (eg grey or green cabinets on the street that house active and passive broadband equipment), which is then connected to premises via the pre-existing copper connection (FTTC). In this way, higher broadband speeds are achievable without the huge costs of connecting every home to fibre cable.

Fibre to the Cabinet (FTTC)

This is the most common form of broadband connection in the UK, which uses the existing copper telephone network. Fibre is installed to the local telephone cabinet, and the remaining distance to each premises uses the existing copper line. This technology can typically provide superfast speeds (24Mbps and above), but the received speed depends on the distance between the cabinet and the premises. This is because transmission speeds are limited along a copper line, and so the longer the length of copper between cabinet and premises, the lower the speeds achievable. Typically superfast speeds are only achievable up to line lengths of 800m-1km from a cabinet, while speeds of 10Mbps are still generally achievable with line lengths of 1800m-2km. The government's Superfast

Broadband Programme has extended superfast broadband to 95% of UK premises, primarily through the use of FTTC.

Fibre to the Remote node

Fibre to the remote node works on a similar principle to FTTC, except that it brings fibre much closer to the premise or allows smaller clusters of premises to be covered cost-effectively. Remote nodes are typically a tiny street cabinet, or on a telegraph pole or inside manhole covers. Reducing the length of copper used to reach reach premises can enable higher speeds to be achieved.

Cable (hybrid fibre coaxial)

This is another prevalent form of fixed line broadband infrastructure in the UK, where fibre is installed to a nearby cabinet, and then segments of a coaxial copper cable connect premises in the vicinity. Virgin Media use this technology, and are offering ultrafast speeds of up to 300 Mbps to residential consumers.

Fibre to the Premise

This is where optical fibre is run from the exchange all the way through to the premises, allowing for a very quick and fully future proofed internet connection. Speeds offered over FTTP are far above the national average - typically up to 1Gbps - and very high upload speeds are also offered, which is particularly useful for businesses or those working from home.

There are two deployment options. The first involves a dedicated fibre connection to each property, which offers the fastest speeds but is expensive to deploy. The second option, which is cheaper and more commonly used in the UK, is for a single fibre connection to be shared by neighbouring properties. However, speeds may be limited, particularly at peak time, compared to the dedicated approach.

Fixed Wireless

Fixed wireless broadband is the operation of wireless devices or systems used to connect two or more fixed locations (e.g. building to building or tower to building).

The advantages of fixed wireless include the ability to connect with users in remote areas without the need for physical (wired) connection (e.g. laying new cables). A small dish is attached to the side of the consumer’s property, which can be paid for outright by the developer or rented by the consumer. This then links into a local transmitter which is connected to the fibre network spine. Fixed wireless devices usually derive their electrical power from the public utility mains, unlike mobile wireless or portable wireless devices which tend to be battery powered.

While many Wireless Internet Service Providers (WISPs) operate on a small scale, with coverage of a few hundred homes served from a small number of masts, others have made significant investment in their networks. Some WISPs have built several hundred masts covering large geographic areas and several hundred thousand homes across the UK are within the coverage footprint of a WISP network. WISP service offerings vary with many providing superfast and some ultrafast speeds of 100Mbps+, or as high as 1Gbps. Other than in rural areas, dedicated spectrum is preferred. Higher speeds generally require investment to increase mast density or additional spectrum.

In terms of affordability, there is no great difference between fixed wireless and fixed line broadband when it is taken into account that fixed wireless customers will not need to rent a phone line and can instead use Voice Over the Internet applications like Skype.

4G:

4G mobile communications is a different proposition to traditional, fixed broadband, but its importance in the sector is expected to grow in the coming years. The mobile broadband industry is delivering 4G to the vast majority of premises in the UK, and coverage is rising rapidly.

The four MNOs committed to invest £5 billion up to 2017 as a result of the landmark agreement between the Government and the MNOs in 2014. Ofcom's licence obligations arising from this agreement required all all four MNOs to provide voice and text coverage across 90% of the UK's geographic area by the end of 2017. In addition, Telefonica (O2) has a separate licence obligation to provide 4G indoor coverage (at least 2Mbps download data rate) to 98% of the UK population also by the end of 2017. Ofcom are assessing the results. We will also see 4G+ begin to spread across the UK and probably become available in 20+ cities by 2018. Vodafone with its Open Sure Signal technology and EE with its micro-network technology are providing improved services to rural areas, where broadband infrastructure is already available.

4G has the capability to offer basic broadband or even high-speed services for areas where there is mobile signal or to users do not want to use a fixed line. Despite the high 'headline speeds' from 4G mobile operators, 4G mobile services will not – in general – be capable of delivering a 24Mbps+ broadband service for some years, or being equivalent to good fixed line services, but might be capable of offering a 5-10Mbps service in some areas. This is because 4G mobile operators are unlikely to be able to cope with the data requirements of large numbers of consumers using the service as their main connection.

In terms of affordability for customers, one consideration to be aware of is that at any given data limit per month mobile packages currently tend to be considerably more expensive for consumers than fibre or fixed wireless packages.

4G is an eligible technology under the Better Broadband Scheme and consumers are increasingly taking a fixed 4G service in preference to satellite.

Satellite

Delivering broadband through satellite technology requires a physical satellite to facilitate the connection. The majority of satellites currently used are located in geostationary orbits. This means they appear to remain fixed above one location on the Earth's surface, normally over the equator, enabling them to always receive and send signals back and forth to the same area on Earth. A geostationary orbit has to be at an altitude of about 23,000 miles above Earth, hence their "footprint" (the area covered by their signal) is extremely large.

In 2016, for the first time, Ofcom collected satellite fixed broadband connection figures from the UK's largest satellite service providers; these data indicate that there were around 80,000 such connections at the end of the year[96].

Each satellite has finite capacity for these connections; only a finite number of premises can connect to satellite broadband via each individual satellite. Aggregate capacity for UK-wide provision (Avanti, Astra, Eutelsat) is limited to an estimated 30,000-60,000 customers at present. It takes hundreds of millions of pounds in investment and years of development before new satellites can be built and launched. The estimated cost of launching a new satellite is in the region of £250m.

The expense of building, launching and operating satellites is necessarily passed on to the consumers using their services. A consumer will typically spend between £250 and £600 on Satellite hardware (depending on the offer, satellite type and consumer location). This will be in addition to an installation fee and monthly line rental. Monthly costs have the potential to be a barrier to take up due to modern usage requirements. For example, if consumers choose a satellite package that can deliver around 215GB[97] per month - the current average monthly residential usage for a 10Mbps+ connection - then today they would be paying approximately £70+ per month[98]. By way of comparison, an unlimited data 17Mbps service with BT costs £29.99 per month (including line rental).[99]

Satellite broadband tends to have stricter limits in terms of how much information you can send and receive, as opposed to ground-based technologies. This, combined with higher latency than other broadband solutions, which can impact on the quality of real-time applications like phone or video calls and gaming, means that satellite can often be considered less favourably than territorial broadband services. However it can still provide a useful stop-gap measure for isolated rural areas where terrestrial broadband connectivity has yet to deliver, although they usually cannot compete with the greater affordability of established fixed line ISPs.

Satellite is an eligible technology under the Better Broadband Scheme and its availability means that all premises in the UK can have access to speeds of more than 2Mbps. There has been no indication that the available satellite capacity is likely to be a constraint at present. Even consumers with speeds below 2Mbps who are able to access a subsidy which pays for the capital installation costs are currently not likely to take it up. Further, consumers are increasingly opting for a fixed 4G service in preference to satellite where this is possible, and some of the satellite retailers are offering both technologies or even moving out of satellite altogether.

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96 https://www.ofcom.org.uk/__data/assets/pdf_file/0017/105074/cmr-2017-uk.pdf, page 144

97 Ofcom's figure for current average monthly data usage https://www.ofcom.org.uk/__data/assets/pdf_file/0024/108843/summary-report-connected-nations-2017.pdf, pg 8

98 Based on average of suppliers' subscription packages

99 https://www.productsandservices.bt.com/products/broadband-packages

A number of non-geostationary orbit (NGSO) broadband satellites are to be deployed in the 2019-2021 timeframe will increase the available capacity. The launch of Low Earth Orbit satellites could reduce latency in future.