Ofcom
making communications work
for everyone

Improving broadband and landline standards

A review of how Ofcom's service quality rules have affected Openreach's service level performance

[✂] – redacted for publication

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Annex

1. Overview

1.1 Broadband access is increasingly important to UK consumers. Between 2009 and 2018, the proportion of UK households with fixed broadband increased from 65% to 80%.[1] In 2019, almost nine in ten (87%) UK households had internet access, with 82% of people using home broadband.[2,3]

1.2 Many broadband and landline providers use Openreach's network to deliver their services to customers. Openreach is responsible for maintaining and investing in its network, to ensure customers experience a reliable service.[4,5] The quality of the services provided by Openreach to telecoms providers is therefore vital to consumers' broadband and landline experience.

1.3 Between 2009 and 2012, the quality of service provided by Openreach decreased steadily for the time taken to carry out installations of new services, and repairs.[6] So, in 2014 we put in place minimum quality of service standards on Openreach.[7] These, along with other policies, were aimed at making sure Openreach improved its service level performance.[8]

1.4 We have looked at the difference these standards have made – looking at whether they have led to an improvement in Openreach's performance. This also allows us to uncover any lessons learned, which could help inform future decisions and ensure our policies are as effective as possible. Evaluations also help make us accountable for the regulatory decisions we make.

1.5 We chose this intervention to evaluate because (a) it is strategically important, given the number of end customers affected and opportunities for lessons learned; and (b) we believed that we would obtain meaningful results, given data quality and availability.

[1] Ofcom, 2018. *Communications Market Report*, Figure 1.3.
[2] Ofcom, 2019. *Online Nation Report 2019*, page 2.
[3] As fibre-based services are rolled out and communications providers plan to retire the copper-based public switched telephone network (PSTN), consumers and businesses will increasingly move to digital lines where voice calls are carried over broadband.
[4] Openreach is the part of BT which maintains and builds fixed telephone and broadband networks used by most households and businesses in the UK.
[5] The exceptions are Virgin Media and telecoms providers in the Hull Area. Virgin Media owns its own network. For historic reasons, the network in Hull is owned by KCOM and not BT.
[6] Ofcom, 2014. *Fixed Access Market Review 2014*, volume 1, paragraph 11.11 citing the July 2013 FAMR.
[7] Ofcom, 2014. *Fixed Access Market Review 2014*, volume 1, paragraphs 11.1 to 11.3. The 2014 QoS intervention did not regulate services for Generic Ethernet Access Fibre to the Cabinet. Minimum quality levels for this service were introduced in 2018.
[8] Other relevant policies include *Automatic Compensation*, and *Comparing Service Quality* reports.

Our assessment

We used regulatory reporting data to measure the impact of the QoS intervention on Openreach's repairs and installations service levels.

What we have found

Since we introduced minimum quality of service standards:

1. service quality for on-time installations and repairs has improved for almost all services and combinations of products and care levels; and
2. services have become more reliable (i.e. there is lower variability in service levels).[9]

Our analysis shows that, each time we increased the minimum service levels, repair service levels increased, on average, by around 2.6 percentage points. For 2019, this is the equivalent of around 136,000 more repairs taking place on time than would otherwise have been the case.

We also spoke to telecoms providers to get their views on how Openreach's service performance has changed since we introduced the minimum standards. They confirmed that Openreach's quality of service (i.e. services delivered on-time) had, on average, improved. They also confirmed the service was more reliable than it had been prior to the introduction of the standards. They told us that improvements in service quality and reliability – were, in part, a result of the standards.[10]

We also learned the following lessons:

1. **Phased introduction of regulatory controls can help companies to adjust to new standards.** Some telecoms providers suggested that the initial minimum standards were too lenient and, therefore, did not immediately bring about improved services. However, when introducing the standards, we knew at the time that Openreach would need time to restructure and hire enough engineers to be able to comply.[11] Therefore, the standards were deliberately designed to become more stretching over time.[12]
2. **The risk of reputational harm is an important incentive to comply with the regulation.** A number of telecoms providers told us that Openreach had a strong incentive to improve performance because of our monitoring and the risk of reputational harm if it did not meet the standards we had set. As part of the standards, Openreach must publish its performance on important measurements.
3. **We should continue to be mindful that quality standards can potentially induce unintended demand and supply changes.** When we introduced the new standards, we were aware that it could lead to Openreach switching resources away from services not covered by the standards to services covered by them. Another potential outcome was that some customers might switch to products with lower care levels as the reliability of those products increased because of the

[9] [✂]
[10] Stakeholders also mentioned potential technological improvements. See Technical annex for our assessment of the impact of technology and other factors on Openreach's service level performance.
[11] Ofcom, 2014. *Fixed Access Market Review 2014*, volume 1, paragraph 11.267.
[12] Ofcom, 2014. *Fixed Access Market Review 2014*, volume 1, paragraph 11.267.

new standards. [13] However, we did not find evidence that service standards had dropped for unregulated services nor did we find evidence that more customers were switching to services with lower care levels.

[13] When renting a wholesale access line to a telecoms provider, Openreach offers several 'service maintenance levels' (also referred to as 'care levels') which relate to the speed at which it contractually agrees to repair faults. Care levels with faster repair times have a more expensive annual rental price. See paragraph 2.14 for more information on care levels.

2. Background to the QoS intervention

Introduction and summary

2.1 In this section we describe Openreach's services for which we put in place minimum quality of service standards (the 'QoS intervention') and the importance of Openreach's quality of service performance for consumers (paragraphs 2.4 to 2.18). We then describe the concerns Ofcom had about Openreach's performance prior to the QoS intervention (i.e. in the period between 2009 and 2014) and provide a summary of the remedies we put in place to address these service quality concerns (paragraphs 2.19 to 2.40).

2.2 Taken together, these factors – importance of the services and depth of the intervention – indicate the strategic importance of the QoS intervention and therefore the value in evaluating it now, some years after it first took effect.

2.3 We also describe the on-going data submissions which Openreach is required to provide to Ofcom and which Ofcom uses to monitor Openreach's performance (paragraph 2.41). The availability of good quality data since the start of the QoS intervention indicated to us that we were likely to obtain meaningful results and therefore the ability to successfully undertake an evaluation of the policy after it has taken effect. We refer to this and similar evaluations as *'ex-post evaluation'*.

Importance of Openreach's quality of service to customers

2.4 To provide calls and broadband to their customers, most UK telecoms providers rely on access to the network owned by BT and operated by Openreach.[14,15] While Openreach is responsible for most of the network, it does not sell retail services to end customers. It is telecoms providers such as Sky, TalkTalk and BT's own retail divisions ('retail providers') who buy wholesale services from Openreach and package these up to sell retail services to end customers.

2.5 This means that a customer's experience of these services depends on many factors including access and maintenance of Openreach's network. For the most part, however, this is invisible to customers of fixed broadband services. That is, when a problem occurs, customers often do not know where it originates and, in particular, whether the root cause lies with their retail provider or with Openreach.

2.6 Openreach's service quality can have a significant impact on retail providers and their performance and, ultimately, end-users' experience. Inadequate service quality provided by Openreach could undermine the actual or perceived reliability of telecoms providers, hampering their ability to compete and discouraging consumer switching. In other words,

[14] Openreach is the part of BT which maintains and builds phone and broadband networks used by most households and businesses in the UK.
[15] The exceptions are Virgin Media and telecoms providers in the Hull Area. Virgin Media owns its own network. For historic reasons, the network in Hull is owned by KCOM and not BT.

Openreach performance can influence the retail providers' reputation in the eyes of their end-users.

2.7 The main wholesale fixed access line products which telecoms providers rent from Openreach to provide call and broadband services are:

- Wholesale Line Rental ('WLR'), which allows telecoms providers to rent telephone lines on wholesale terms from BT, and resell the lines to customers, providing both line rental and, when combined with a wholesale calls product, voice calls;
- Local Loop Unbundling ('LLU') through Metallic Path Facility ('MPF'), which allows telecoms providers to rent copper access lines on wholesale terms from BT, and connect the lines to their own electronic equipment to offer voice and broadband services to customers; and
- Virtual Unbundled Local Access ('VULA') via Openreach's Generic Ethernet Access Fibre to the Cabinet ('GEA-FTTC'). This gives retail providers access to BT's fibre networks to supply superfast broadband services in combination with either WLR or MPF.[16]

2.8 The performance of broadband services is dependent on numerous factors. These include:

a) the customers' home wiring and router;

b) the Openreach network;

c) the retail providers' choice of service level agreement (see paragraph 2.15); and

d) retail providers equipment, operational processes and systems.

2.9 It follows that, to improve the customer experience, Openreach and retail providers must work together to determine where and why problems arise, and to resolve them promptly. Openreach's performance is therefore critical to ensuring end customers do not receive poor quality broadband services.

2.10 This performance is particularly important across the following services provided by Openreach:

a) Repairing faults – when a fault originates in Openreach's fixed access network, retail providers must engage with Openreach and arrange for it to undertake a repair. The likelihood of a fault occurring is, in part, determined by how Openreach maintains its network.

b) Installing new lines – retail providers may require the involvement of Openreach engineers to provide services, for example to install new lines to the customer's premises, or to switch the customer from one provider to another.

2.11 In what follows we explain more fully what we mean by repairs and installations in the context of Openreach's quality of service.

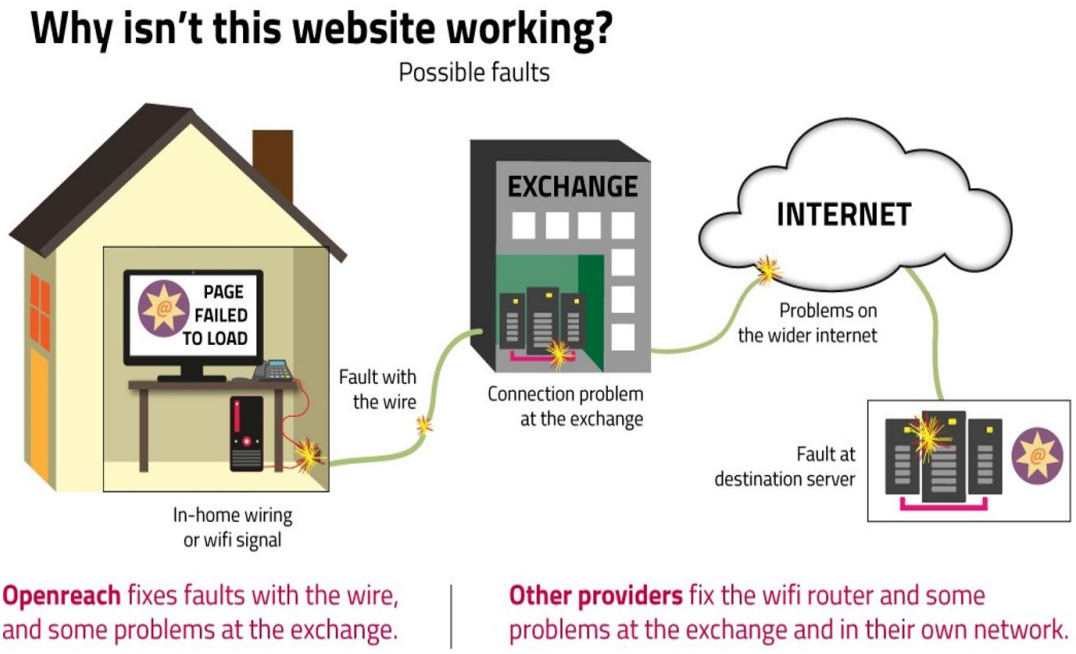
[16] Minimum service quality regulation was introduced for GEA-FTTC in 2018. It was therefore too soon to measure the impact of this intervention and it is outside of the scope of our analysis. VULA is now also available over the more recent Openreach product delivering fibre-to-the-premises (GEA-FTTP), which allows retail providers to offer ultra-fast broadband services. This too is not included in our analysis.

What we mean by repairs

2.12 Customers will inevitably experience faults with their communications services from time to time. Some of these faults can be resolved directly by customers' retail providers, but in

2.13 many cases the provider will need to arrange for Openreach to visit the customer to resolve the fault. See Figure 2.1 below.

Figure 2.1: Fault responsibility in the supply of broadband



2.14 The wholesale services purchased by telecoms providers for the delivery of telephone and broadband services to their customers come with an associated 'service maintenance level' (also referred to as 'SML', or 'care level'). The SML selected by the retail provider sets the contractual time period by which Openreach should repair faults. Contracts agreed between Openreach and retail providers include Service Level Guarantees (SLGs). Amongst other information, the SLGs set out the compensation that Openreach pays providers if it does not meet service level standards.

2.15 When renting a wholesale access line to a telecoms provider, Openreach offers several SMLs which relate to the speed at which it contractually agrees to repair faults. SMLs with faster repair times have a more expensive annual rental price. The five care levels that Openreach currently offers are:

- SML1: Fault clear by 23:59 day after next, Monday to Friday, excluding public and bank holidays;
- SML2: Fault clear by 23:59 next day, Monday to Saturday, excluding public and bank holidays;
- Business 2 Plus or SML2.5: Prioritised on the day, fault clear by 23:59 next day, Monday to Saturday, excluding public and bank holidays;

- SML3: Report by 13:00, fault clear by 23:59 same day. Report after 13:00, fault clear by 12:59 next day, seven days a week, including public and bank holidays; and
- SML4: Fault clear within six hours, any time of day, any day of the year.

What we mean by installations

2.16 Residential and business customers order fixed telephone and / or broadband services from retail providers typically when:

- choosing to switch from one telecoms provider to another;
- moving from one property or premises to another (where the new property or premises may or may not have an existing network connection);
- choosing a new service or package of services (e.g. upgrading from current generation to superfast broadband); or
- a combination of the above.

2.17 There is a single care level for installations. In 2019/20 Openreach was required to provide 80% of new line installation appointments within 12 days from its request.[17]

2.18 As explained above, Openreach's installations and repairs performance is critical to the supply of broadband in the UK. In the next sub-sections, we describe Openreach's performance prior to Ofcom's intervention in 2014. We then describe in detail the QoS intervention.

QoS intervention

2.19 In 2013, Ofcom published consultations on Openreach's quality of service, along with several other aspects of Openreach's wholesale offering to telecoms providers.[18] The review of quality of service was prompted by evidence of a decline in Openreach's installation and repair services performance, as well as by concerns raised by telecoms providers.[19]

2.20 Following these reviews and subsequent stakeholder consultation, Ofcom decided that Openreach's service levels were too low and intervened with the introduction of minimum quality standards for Openreach's installations and repairs. We refer to this intervention as the QoS intervention.

[17] From 2020/21 this changes to 90% of new line installations within 10 working days. Compliance will continue to be assessed on an annual basis. Ofcom, 2018. *Quality of Service for WLR, MPF and GEA: Statement*, page 5. We note that this document is being published during the Covid-19 crisis and Ofcom has provided updates to communications providers on its approach to enforcement. See: Ofcom, 2020. *Ofcom information on the coronavirus (Covid-19)*.

[18] Ofcom, 2013. Fixed Access Market Reviews: *Wholesaled local access, wholesale fixed analogue exchange lines, ISDN2 and ISDN30*, and *Approach to setting Local Loop Unbundling Charge Controls*. These consultations covered other matters in addition to Openreach's service quality levels.

[19] Ofcom, 2014. *Fixed Access Market Review 2014*, volume 1, paragraph 9.2.

2.21 In this sub-section we set out the concerns Ofcom had in relation to Openreach's quality of service prior to 2014 and provide a summary of the remedies the QoS intervention put into place in 2014.

Openreach's pre-2014 performance

2.22 Ofcom's provisional views on Openreach's pre-2014 performance were set out in two consultation documents:[20]

a) In the July 2013 *Fixed Access Market Review* ('2013 FAMR') *Consultation*, we set out the results of our analysis of service quality, which included our review of Openreach's recent performance, the impact of poor service performance, and our research on the views of consumers and small and medium sized enterprises as to what constitutes good or reasonable service quality. We also examined factors potentially affecting service performance such as the impact of adverse weather and the accuracy of demand forecasts by telecoms providers. In light of that analysis, we proposed to introduce a new condition on Openreach imposing minimum service standards for fault repairs and new line provisions (i.e. installations), where an engineer needs to visit the end-user's home or business.

b) In the December 2013 *Local Loop Unbundling WLR Consultation*, having considered responses received from stakeholders to our proposals, we set out the results of our analysis to support the proposed level of minimum standards. We also presented our analysis of the associated cost impact of the minimum standards.

2.23 Following feedback from stakeholders on the December 2013 consultation document, we published the 2014 *Fixed Access Markets Review* ('2014 FAMR'). We undertook a review of matters relating to quality of service, delivered by Openreach, in the supply of regulated wholesale fixed access services. We determined that: *"there had been a steady decline in the level of service provided by Openreach since at least 2009"*.[21]

2.24 Moreover, absent intervention by Ofcom, we expected the decline in service levels to continue and potentially undermine the rules giving telecoms providers access to Openreach's network:

"*[I]n light of the evidence we have gathered and of our consideration of Openreach's incentives, we consider that the range and degree of detrimental effects resulting from current levels of Openreach service quality are likely to continue unless further action is taken, such that they risk undermining the network access remedy*".[22]

2.25 These concerns led us to conclude that the low quality of service had the potential for significant impact on competition both between retail providers using Openreach services and others, and also between BT and other retail providers.[23]

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[20] Ofcom, 2014. *Fixed Access Market Review 2014*, volume 1, paragraphs 9.3 and 9.4.
[21] Ofcom, 2014. *Fixed Access Market Review 2014*, volume 1, paragraph 11.12.
[22] Ofcom, 2014. *Fixed Access Market Review 2014*, volume 1, paragraph 11.55.
[23] Ofcom, 2014. *Fixed Access Market Review 2014*, volume 1, paragraph 11.178.

2014 FAMR QoS intervention

2.26 Having established that Openreach's low service quality levels were problematic, we decided to implement minimum quality standards on the affected services. Moreover, we concluded that any quality standard should be relatively high, given the strong negative effects of low levels of service quality on competition and consumers.[24] This was the first time we had regulated minimum quality standards in these markets.[25]

2.27 The 2014 FAMR contained a package of measures to incentivise improvements in Openreach's service quality levels. These were:

a) Minimum quality standards on repairs and installation services. The minimum standards would increase over time to give Openreach an opportunity to adjust, so that it could deliver the service levels (more details included in paragraphs 2.32 - 2.40).

b) Penalties for failure to comply with the minimum standards, in line with Ofcom's Enforcement Guidelines and Penalty Guidelines.[26] This would provide a financial incentive to comply with the minimum quality standards.

c) To improve transparency, we required Openreach to report a set of key performance indicators ('KPIs') on service levels to Ofcom and to industry (more details included in Technical annex).[27,28] This would provide a reputational incentive to comply with the minimum quality standards.

2.28 These quality of service standards applied to repairs and installations for WLR and MPF, the copper-based access services which were most used by customers.

2.29 We did not introduce quality standards for GEA services in the 2014 FAMR. This was because, at the time, access to GEA services was limited to a relatively small number of customers and we focused on the services which would have the highest impact.

2.30 However, in 2018 we introduced quality of service measures for GEA-FTTC Care level 2, that came into effect from 1 April 2018. As minimum standards for this service were introduced only recently, it is too soon to measure their impact and we have not included them in this review.[29,30]

2.31 Below we provide more detail on the service levels imposed on Openreach and how the service levels have evolved over time.

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[24] Ofcom, 2014. *Fixed Access Market Review 2014*, volume 1, paragraph 11.179.
[25] Ofcom, 2014. *Fixed Access Market Review 2014*, volume 1, paragraph 11.59.
[26] Ofcom, 2014. *Fixed Access Market Review 2014*, volume 1, paragraph 11.292.
[27] Ofcom, 2014. *Fixed Access Market Review 2014*, volume 1, paragraph 11.297.
[28] Relevant KPIs are for WLR, ISDN30, ISDN2, MPF, SMPF and GEA (FTTC and FTTP).
[29] For GEA-FTTC - SML2, the minimum standard was introduced later (April 2018) than for other services (August 2014) and has been raised only once since then (April 2019). For this reason, it is too early to obtain robust findings on the impact of our QoS intervention on these. However, early analysis shows that relevant service levels improved when minimum standards were introduced and remained above these for the entire period.
[30] QoS for ethernet services came in at the same time and for similar reasons. However, they do not relate to services used by residential consumers and, as such, they are not included in this review.

Minimum standards for repairs

2.32 As mentioned in paragraph 2.15 above the wholesale services purchased by retail providers come with an associated care level (or SML).

2.33 The vast majority of services are provided at SML1 and SML2, so these have been the focus of our QoS intervention. The annual standards for the proportion of repairs completed within the contractual times and their evolution over time are summarised in Table 1 below.

Table 1: QoS minimum standards for Openreach's repair performance – proportion of repairs completed within the contractual timeframes for WLR, MPF and GEA-FTTC (including adjustment for force majeure[31])[32]

Product	Care level	Aug 14 to Mar 15	Apr 15 to Mar 16	Apr 16 to Mar 18	Apr 18 to Mar 19	Apr 19 to Mar 20
WLR	**SML1**	67%	72%	77%	80%	83%
WLR	**SML2**	67%	72%	77%	80%	83%
MPF	**SML2**	67%	72%	77%	80%	83%
GEA-FTTC	**SML2**	n/a	n/a	n/a	80%	83%

Source: Ofcom.

2.34 The above table shows that the repair standards:

a) were first introduced in August 2014 for WLR and MPF;

b) increased four times (in April 2015, April 2016, April 2018, and April 2019) for each service;

c) have been at 83% for each service since April 2019;[33] and

d) were first introduced for GEA-FTTC in April 2018.

Minimum standards for installations

2.35 We set QoS standards on how quickly Openreach offers an appointment for engineering visits for provisions (first available date), and for the proportion of installations completed by the contractually agreed date (committed date).[34]

[31] A fixed allowance of 3% on repair standards to take account of events which are beyond Openreach's reasonable control.
[32] From November 2017, for regulatory purposes the Repair QoS standards are enforced for all services at each SML, i.e. WLR - SML2, MPF - SML2, GEA-FTTC - SML2 are collectively assessed against the repair standard for SML2.
[33] From 2020/21 this changes. Openreach will be required to repair faults within one or two working days 85% of the time (including adjustment for force majeure). Compliance will continue to be assessed on an annual basis. See Quality of Service for WLR, MPF and GEA: Statement, p7, Table 1.2.
[34] For each of these we allowed for fixed 1% allowance for Local 'Matters Beyond Our (BT's) Reasonable Control' ('MBORC') events.

2.36 In particular, in August 2014 we required Openreach to offer retail providers with a First Available Date (FAD) for an appointment with their customer within 12 working days 54% of the time. In April 2016 we extended these standards to GEA-FTTC services. Over time we have increased this standard as shown in Table 2 below.[35]

Table 2: QoS minimum standards for Openreach's installation performance – First Available Date (FAD) for WLR, MPF and GEA (including adjustment for force majeure)

Product	Aug 14 to Mar 15	Apr 15 to Mar 16	Apr 16 to Mar 18	Apr 18 to Mar 19	Apr 19 to Mar 20
WLR	54%	67%	79%	89%	89%
MPF	54%	67%	79%	89%	89%
GEA-FTTC	n/a	n/a	n/a	89%	89%

Source: Ofcom.

2.37 The above table shows that the FAD standards:

a) were first introduced in August 2014 for WLR and MPF;

b) increased annually in April for each service;

c) plateaued at 89% from April 2018 and this is the level that they have remained at;[36] and

d) were first introduced for GEA-FTTC in April 2018.

2.38 In addition to obtaining an appointment, a measure of service quality is that services are installed when they have been promised. When Openreach misses an installation date, this can cause both costs and frustration to retail providers and end customers.

2.39 In August 2014, we also required Openreach to meet the promised installation date 89% of the time and have since increased this requirement as shown in Table 3 below.[37] In April 2018 we extended such standards to GEA-FTTC services.

Table 3: QoS minimum standards for Openreach's installation performance – On time installations for WLR, MPF and GEA FTTC (including adjustment for force majeure)

Product	Aug 14 to Mar 15	Apr 15 to Mar 16	Apr 16 to Mar 18	Apr 18 to Mar 19	Apr 19 to Mar 20
WLR	89%	89%	89%	91%	91%
MPF	89%	89%	89%	91%	91%
GEA-FTTC	n/a	n/a	n/a	91%	91%

Source: Ofcom.

[35] From 2020/21 this changes to 90% of new line installations within 10 working days. Compliance will continue to be assessed on an annual basis. Ofcom, 2018. *Quality of Service for WLR, MPF and GEA: Statement*, page 5

[36] In April 2020 the FAD minimum standards did not increase. Ofcom, 2018. *Quality of Service for WLR, MPF and GEA: Statement*, page 8, Table 1.3.

[37] From 2020/21 this changes to 95%. Compliance will continue to be assessed on an annual basis.

2.40 The above table shows that the installation standards:

a) were first introduced in August 2014 for WLR and MPF;

b) were unchanged until March 2018 for each service;

c) increased in April 2018;

d) have remained at the April 2018 levels since;[38] and

e) were first introduced for GEA - FTTC in April 2018.

2.41 Finally, as part of our QoS intervention we asked Openreach to provide us with monthly KPI data for repairs, FAD and installations for a number of wholesale services including WLR, MPF, GEA - FTTC, GEA - FTTP, ISDN2, ISDN30, and SMPF. We provide more details in Technical annex.

Conclusion

2.42 The foregoing provides background on the QoS intervention: why we decided to intervene with minimum quality standards (paragraphs 2.22 to 2.25) and how we intervened (paragraphs 2.26 to 2.41).

2.43 This background demonstrates that the QoS intervention was, and is, a strategically important regulation (paragraphs 2.4 to 2.6) and, given data availability (paragraph 2.27c)), we would expect to be able to obtain meaningful results from the *ex-post* evaluation of this regulation. Taken together, these factors indicated to us that this intervention was a good candidate for *ex-post* evaluation.

2.44 We use the KPI data briefly introduced in this section to undertake this *ex-post* evaluation of the impact of the QoS intervention on Openreach's service performance. We provide a summary of our analysis and results in the next section.

[38] From 2020/21 this changes. Openreach will be required to complete installations by the committed timing 94% of the time (including adjustment for force majeure). Ofcom, 2018. *Quality of Service for WLR, MPF and GEA: Statement*, page 8, Table 1.3.

3. The impact of the QoS intervention on Openreach's service quality levels

Introduction and summary

3.1 As noted in Section 2, Openreach began providing us with KPI data when the QoS minimum standards were introduced in August 2014. We do not have KPI data for the period before the QoS intervention to compare with Openreach's performance since the intervention. Instead, we have used the KPI data (described in the Technical annex) to assess the impact of the QoS intervention's minimum standards since August 2014 and for the refence period August 2014 to December 2019. This KPI data is for repair services and installations. In this section we present our results from the analysis of this KPI data.

3.2 **For repairs**, we start with graphical analysis and descriptive statistics. Firstly, we analyse trends over time (paragraphs 3.10 to 3.22):

a) trends in service quality levels over time;

b) compare actual service levels to minimum service levels over time; and

c) assess reliability of service levels over time.

3.3 Secondly, we compare (a) service levels for product-care level combinations regulated by QoS[39] with (b) those product-care combinations which did not have minimum standards regulated by the QoS intervention[40] (paragraphs 3.23 to 3.43). This analysis provides indicative evidence of the impact of the QoS intervention on Openreach's service performance as, absent Ofcom's intervention, we would expect these two categories of service to evolve according to a similar trend. However, there are limitations to this analysis because the services which do not have service quality regulation have low volumes.

3.4 Thirdly, we estimate econometric models which allow us to isolate the impact of the QoS intervention's minimum standards on actual service levels. That is, the models allow us to separate the impact of the QoS intervention from the impact of other factors which may have led to improvements in Openreach's service levels (such as technological improvements).

3.5 We estimate two kinds of econometric models, time series (paragraphs 3.44 to 3.55) and panel data (paragraphs 3.56 to 3.63) (see Technical annex, paragraphs A1.26 to A1.40 for a detailed descriptions of these models):

a) Time series datasets contain observations about a variable or a set of variables over time.

[39] These are WLR - SML1, WLR - SML2 and MPF - SML2.
[40] These are WLR - SML3 and MPF - SML3.

b) Pooled cross-section data contain time series data for observations which are different in each period (it is very unlikely that installations and repairs for the same customer appear in each period of our analysis). We combined all observations for all periods to create a 'pooled' dataset.[41]

3.6 The time series and panel data models have their advantages and limitations. By undertaking the analysis using both kinds of models, we aim to ensure that we can have confidence in our findings.

3.7 Overall, our analysis tends to indicate that, for repairs, the QoS intervention has led to:

a) higher service levels in recent periods than in the period immediately after the intervention;

b) improved reliability over time; and

c) with the exception of the early years of the intervention, the QoS intervention led to service levels for repairs improving over time with each increase in minimum standards.

3.8 **For installations**, we do not have sufficient data to estimate econometric models. As we are unable to isolate the impact of the minimum standards on actual service levels, we provide a summary of the trends in FAD and installations (paragraphs 3.64 to 3.71).

3.9 Overall, we find that Openreach's performance for repairs and installations seems to be linked to the minimum standards set by Ofcom: an increasing minimum standard is generally accompanied by improved performance if the standard is sufficiently stretching (paragraphs 3.72 to 3.74), i.e. if it is not too far from the current performance level.

Repairs service KPIs

Trend analysis

3.10 We use the time-series data described in Technical annex (paragraph A1.4 onwards) to assess service level trends over time. For repairs KPIs, we assess:

a) trends in service quality levels over time;

b) compare actual service levels to minimum service levels over time; and

c) assess reliability of service levels over time.

3.11 Firstly, we provide this analysis for WLR - SML1 and WLR - SML2. Secondly, we provide it for MPF - SML2.

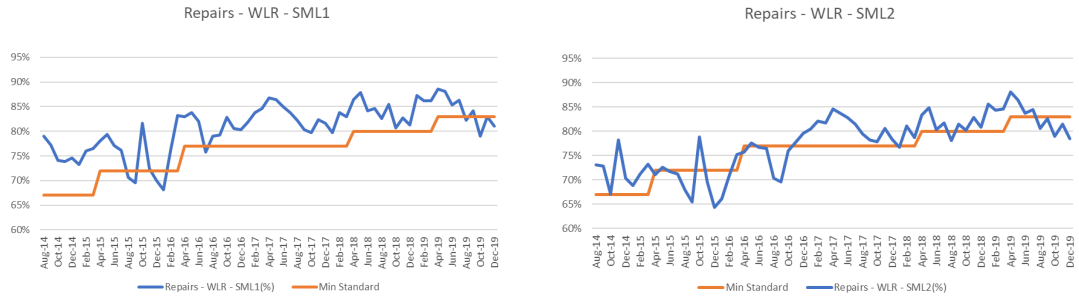
[41] JM Wooldridge, 2003. *Introductory Econometrics*, second edition, Chapter 1, page 10.

Trends for WLR - SML1 and WLR - SML2

3.12 Minimum standards for repairs under WLR - SML1 and WLR - SML2 were introduced in August 2014 and were increased on four occasions (April 2015, April 2016, April 2018, and April 2019).[42] In this sub-section, we assess trends in actual repair service levels over time. We also compare the actual service levels with the minimum standards imposed by the QoS intervention and assess the changes in service reliability over time. We do this for WLR - SML1 and WLR - SML2.[43]

3.13 The below charts show the repairs service levels delivered by Openreach (blue line) and the minimum standards in the QoS intervention (orange line) for WLR for the period August 2014 to December 2019. The panel on the left is for the SML1 service level agreement. The panel on the right is for the SML2 service level agreement.

Figure 3.1: Trends in actual repairs and minimum standards for WLR - SML1 and WLR - SML2, August 2014 to December 2019



Source: Ofcom analysis of Openreach regulatory reporting data.

3.14 The above figures show that relevant KPIs declined slightly when standards were introduced (August 2014) and after the first change (April 2015), but subsequently increased over time.

3.15 Actual service levels increased after the standard increased for the second time (April 2016). This is clear when we consider that:

a) In the period immediately before April 2016 (i.e. April 2015 – March 2016) Openreach delivered fault repairs within the service level agreement 75% of the time for WLR - SML1 services, and 70% of the time for WLR - SML2 services.

b) In subsequent periods, there were higher rates of repairs delivered on time than in the period April 2015 – March 2016:

   i) For WLR - SML1 – 82% (April 2016 – March 2018), 85% (April 2018 – March 2019) and 84% (April 2019 – December 2019).

[42] See Section 2, Table 3.

[43] For GEA-FTTC - SML2, the minimum standard was introduced later (April 2018) than for other services (August 2014) and has been raised only once since then (April 2019). For this reason, it is too early to obtain robust findings on the impact of our QoS intervention on these. However, early analysis shows that they have increased exactly when minimum standards were introduced and remained above these for the entire period.

ii) For WLR - SML2 – 79% (April 2016 – March 2018), 82% (April 2018 – March 2019) and 83% (April 2019 – December 2019).

3.16 Similarly, service reliability (i.e. volatility) worsened in the period April 2015 – March 2016 compared to August 2014 to March 2015.[44] However, we observe that the volatility decreased again in the three subsequent periods (April 2016 – March 2018, April 2018 – March 2019, and April 2019 – December 2019) to revert to its original levels – meaning that service reliability improved by the end of the reference period. For completeness, we note that KPIs went below minimum standards again in August 2019, October 2019 and December 2019.

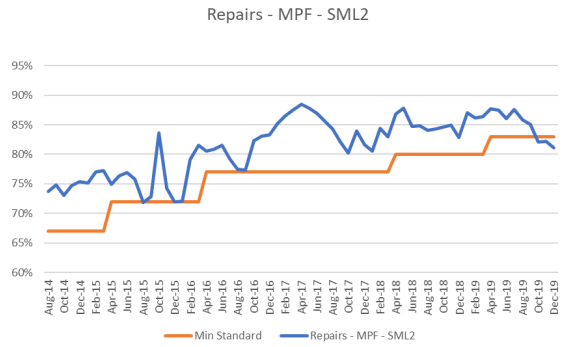
3.17 Compliance with the QoS intervention is based on an annual average and Openreach has never breached the minimum annual service threshold for WLR - SML1 or WLR - SML2. We note that from April 2015 to March 2016 Openreach's performance, on average, was above the minimum thresholds (this average is what counts for the financial penalties). However, in three different months Openreach performance was below the minimum standards for WLR - SML1 and WLR - SML2.[45]

3.18 Actual service levels were also below the minimum standards in August to September 2015 and December 2015 to January 2016 for WLR - SML1; and July 2015 to September 2015, December 2015 to February 2016, and August to October 2016 for WLR - SML2. Service levels were also below the minimum in the final quarter of 2019 for WLR - SML1 and WLR - SML2.

Trends for MPF - SML2

3.19 The figure below shows the repairs service levels delivered by Openreach (blue line) and the minimum standards in the QoS intervention (orange line) for MPF - SML2, for the period August 2014 to December 2019.

Figure 3.2: Trends in actual repairs and minimum standards for MPF - SML2, August 2014 to December 2019



Source: Ofcom analysis of Openreach regulatory reporting data.

[44] Volatility went from 2% to 5% for WLR - SML1 and from 3% to 4% for WLR - SML2

[45] Note that since the standards apply on the basis of an average over the year, a KPI below the standard in a single month does not represent a breach.

3.20 Similar to the trends in WLR service levels, the above chart shows for MPF - SML2:

a) In the periods August 2014 – March 2015 and April 15 – March 16, repairs were delivered on time 75% and 76% respectively.

b) In the subsequent three periods the KPIs increased to 83% (April 2016 – March 2018), 85% (April 2018 – March 2019) and 85% (April 2019 – December 2019).

3.21 As with WLR, actual service levels increased after the minimum standard increased for the second time (April 2016).

3.22 Compliance with the QoS intervention is based on an annual average and Openreach has never breached the minimum annual service threshold for MPF - SML2. Moreover, unlike the WLR - SML1 and WLR - SML2 for repairs shown above, average service quality did not drop below the minimum standard between April 2015 and March 2016, although there was greater volatility in performance during this period. Volatility was 1% from August 2014 to March 2015 and 4% from April 2015 to March 2016. Also, in this case volatility decreased again in April 2016 to March 2018, then in April 2018 to March 2019. It slightly increased, however, in April 2019 to December 2019. We also note that KPIs went below minimum standards again in October to December 2019 potentially due to persistently adverse weather conditions.

Comparisons against services for which we did not impose standards

3.23 In this section we compare Openreach's service levels for products regulated by the QoS intervention with those which are not regulated by the QoS intervention. All else equal, if service levels for products regulated by the QoS intervention improve more quickly than for services not regulated by the QoS intervention, this would provide indicative evidence that the QoS intervention led (or contributed) to service quality improvements.

3.24 As discussed in Section 2, Openreach offers several SMLs (or care levels) which relate to the speed at which it contractually agrees to repair faults. We introduced minimum standards for products (services and care levels) with relatively high volumes. For this reason, in 2014 service levels were regulated for WLR - SML1, WLR - SML2 and MPF - SML2 (and later for GEA-FTTC - SML2). Services which were not subject to the QoS intervention are WLR - SML3 and MPF - SML3.[46]

3.25 In this section we compare trends for service levels for WLR - SML1 and WLR - SML2 (regulated by QoS) with WLR - SML3 (not regulated by QoS). We then compare MPF - SML2 (regulated by QoS) with MPF - SML3 (not regulated by QoS).

3.26 A limitation of this analysis is that volumes for WLR - SML3 and MPF - SML3 are very low. The average costs of the services at these care levels are relatively higher, and small

[46] As explained in the Technical annex, not all care levels were subject to our QoS intervention. Among these, for example, ISDN2 - SML2 also represents a good comparator for WLR - SML2 and MPF - SML2 as they use the same underlying infrastructure. While, to avoid repetitions, we do not show the results in this report, by using ISDN2 as a comparator we obtain results very similar to the ones illustrated below. To further verify the robustness of our findings, all services for which we did not introduce minimum standards, but for which we have data for the entire intervention period, have been included in the panel data analysis.

changes in absolute service levels can lead to large changes in percentages. The comparative analysis that follows is therefore indicative rather than conclusive.

Comparison of WLR - SML1, WLR - SML2, and WLR - SML3

3.27 We take advantage of the fact that for WLR services we imposed minimum standards on SML1 and SML2, but not on SML3. We then compare the trends of the first two to that of the latter. To smooth out short-run variations we:

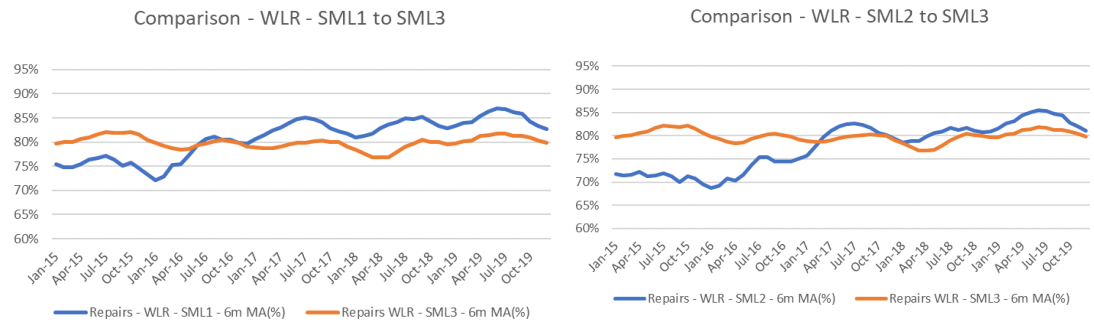
a) compare percentage variations (%) over time; and

b) apply a 6-month moving average to adjust for potential seasonality.[47]

3.28 The left panel in the figure below shows the repairs service levels delivered by Openreach for WLR - SML1 (blue line) and for WLR - SML3 (orange line) for the period August 2014 to December 2019.

3.29 The right panel in the chart below shows the repairs service levels delivered by Openreach for WLR - SML2 (blue line) and for WLR - SML3 (orange line) for the period August 2014 to December 2019.

Figure 3.3: Comparison of actual repairs for WLR - SML1, WLR - SML2, WLR – SML3, August 2014 to December 2019



Source: Ofcom analysis of Openreach regulatory reporting data.

3.30 The chart above shows that, at the time of the beginning of the QoS intervention (August 2014) KPIs for WLR - SML1 and WLR - SML2 were below KPIs for WLR - SML3. However, over the course of the period for which we have data, KPIs for WLR - SML1 and WLR - SML2 overtook KPIs for WLR - SML3 and then remained consistently above it.

3.31 The chart above shows that for SML3:

a) In the period August 2014 to April 2015, Openreach completed repairs within the contractual time 80% of the time.

b) Around five years later, in the period April 2018 to December 2019, the proportion of repairs completed on time was basically unchanged (80%).

3.32 That is, KPIs for WLR – SML3 were broadly flat from August 2014 to December 2019.

[47] One implication of this is that we 'lose' observations for the first 5 months of the reference period.

3.33 By comparison, KPIs for WLR - SML1 and WLR - SML2 improved considerably over the same period. As noted in paragraph 3.15 above, KPIs for WLR - SML1 increased from 75% (April 2015 – March 2016) to 84% (April 2019 – December 2019), and WLR - SML2 increased from 70% (April 2015 – March 2016) to 83% (April 2019 – December 2019).

3.34 As we have no reason to believe that any external factors affecting WLR - SML3 would not have also affected WLR - SML1 or WLR - SML2, this analysis tends to indicate the differences are driven by the QoS intervention.

3.35 We also note (not shown in 3.3) that at the beginning of the reference period KPIs for WLR - SML1 and WLR - SML2 were well below KPIs for WLR - SML3. At the end of the reference period the opposite was true.

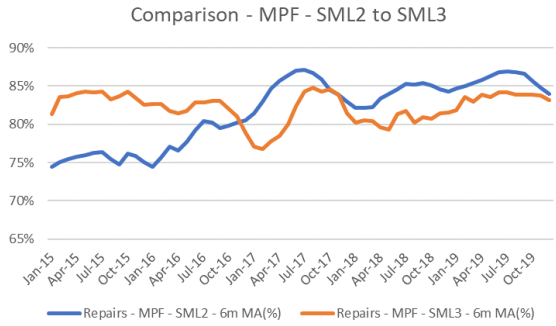
Comparison of MPF - SML2 and MPF - SML3

3.36 In this subsection we compare MPF - SML2 with MPF - SML3. For MPF we take advantage of the fact that for these services we imposed minimum standards on MPF - SML2, but not on MPF - SML3. We use the same data smoothing approach described in paragraph 3.27, i.e. we compare percentage variations over time and use 6-month moving averages.

3.37 The results of the comparison are very similar to the WLR results in paragraphs 3.30 to 3.32 above.

3.38 The figure below shows the repairs service levels for MPF - SML2 (blue line) and MPF - SML3 (orange line), for the period August 2014 to December 2019.

Figure 3.4: Comparison of actual repairs for MPF - SML2 and MPF - SML3, August 2014 to December 2019



Source: Ofcom analysis of Openreach regulatory reporting data.

3.39 The above chart shows that, at the time of the beginning of the QoS intervention (August 2014), KPIs for MPF - SML2 were below KPIs for MPF - SML3. However, over the course of the period for which we have data, KPIs for MPF - SML2 overtook KPIs for MPF - SML3 and then remained consistently above it.

3.40 The chart above shows that, for MPF - SML3 (which is not regulated by the QoS intervention):

a) In the period August 2014 to April 2015, Openreach completed repairs within the contractual time 82% of the time.

b) Around five years later, in the period, April 2018 to December 2019, the proportion of repairs completed on time was basically unchanged (83%).

3.41 That is, despite some fluctuations, KPIs for MPF - SML3 were broadly flat from August 2014 to December 2019.

3.42 By comparison, KPIs for MPF - SML2 (which is regulated by the QoS intervention) improved considerably over the same period. As noted in paragraph 3.20 above, KPIs for MPF - SML2 increased from 76% (April 2015 – March 2016) to 85% (April 2019 – December 2019).

3.43 As we have no reason to believe that any external factors affecting MPF - SML3 would not have also affected MPF - SML2, this analysis tends to indicate the differences are driven by the QoS intervention.

Time series analysis

3.44 As explained in Technical annex, from August 2014 we required Openreach to provide us with relevant KPIs on a regular (monthly) basis. This means that for a number of services and service levels we have a sequence (or series) of data points taken at successive and equally spaced points in time (referred to as 'time series data').

3.45 We use this data to estimate static time series regression models. [48] These models allow us to test whether and to what extent our intervention (i.e. the introduction and the increase of our minimum standards over time) has affected the contemporaneous values of Openreach's KPIs.

3.46 In what follows we present the main results of this analysis. Technical annex provides a detailed description of the models and results.

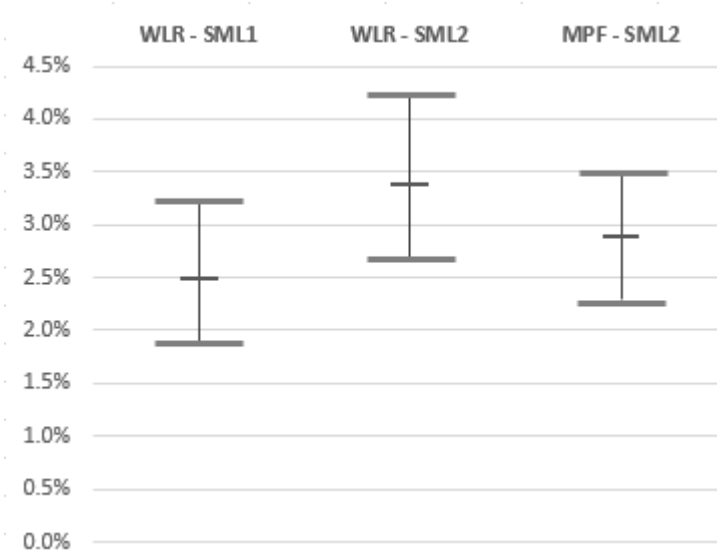
Results

3.47 Figure 3.5 below provides our estimates of the average increase in Openreach's KPIs every time we raised the minimum standard. The centre line for each of the plots is the estimated average effect of the QoS intervention for that product and service level agreement. The lines above and below each plot represent confidence intervals, i.e. the range of values within which we are relatively confident the average falls. [49]

[48] Time series models modeling the contemporaneous relationship between an explanatory variable and a dependent variable are also called static models. These are typically used when a change in the explanatory variable (such as our minimum standard) in any given period is believed to have an immediate effect on a dependent variable (such as Openreach KPIs). See J M Wooldridge, 2003, *Introductory Econometrics*, second edition, Chapter 10, p313.

[49] A confidence interval is a range of values which is likely to contain the true value of the parameter of interest (in our case this is the real impact of an increase in minimum standards). The confidence interval has an associated confidence level that the true parameter is in the proposed range. All ranges included in this section are provided at the 95% confidence level.

Figure 3.5: Estimated average increase in KPIs when the QoS intervention minimum standard increases



Source: Ofcom analysis of Openreach regulatory reporting data.

3.48 Figure 3.5 shows that, every time we raised minimum standards, Openreach performance for:

a) WLR - SML1 services increased by 1.9 to 3.2 percentage points, with our best estimate being 2.5 percentage points;

b) WLR - SML2 services increased by 2.7 to 4.2 percentage points, with our best estimate being 3.4 percentage points; and

c) MPF - SML2 services increased by 2.3 to 3.5 percentage points, with our best estimate being 2.9 percentage points.

3.49 In addition to the above analysis, we tested whether the size of the impact of the QoS intervention on Openreach's performance varied over time. We found that the minimum standards began to have a statistically significant impact on Openreach's performance from April 2016. This is consistent with our findings in Section 4 and confirms stakeholder feedback that our minimum standards delivered the desired benefits as they became more stretching.

3.50 The estimates presented in Figure 3.5 take into account other relevant factors identified by stakeholders which could have had an impact on Openreach's service levels. [50] Our analysis tends to indicate that:

a) rainfall and demand for repairs services – which are generally correlated – have a negative impact on Openreach's performance; and

[50] See section 4 for stakeholders' views on the confounding factors.

b) there are no other seasonal factors in addition to rainfall that have an impact on Openreach's performance.

3.51 By taking these factors into account, we have been able to isolate the impact of the QoS intervention on Openreach's service level performance. In addition, all of the above estimates are statistically significant (see Technical annex), i.e. they are unlikely to be the result of a chance correlation in the data.

3.52 Finally, as an additional robustness check, we estimated the time series models for two products which were not subject to the QoS intervention minimum standards (i.e. WLR - SML3 and MPF - SML3). These models allow us to test whether other relevant factors which we have not included in the time series model have led to increases in Openreach's service levels.

3.53 The assumption is that any other relevant factors which have impacted on services regulated by the QoS intervention would have also impacted on services not regulated by the intervention (i.e. WLR - SML3 and MPF - SML3).

3.54 These models show that there were no other relevant factors that had an impact on Openreach's performance for WLR - SML3 and MPF - SML3 (services which are not regulated by the QoS intervention) in any period after the QoS intervention.

3.55 These results confirm that the variations illustrated in paragraph 3.48 can be fully ascribed to the QoS intervention.

Panel data analysis

3.56 To test the robustness of our time series results, we also estimated a panel data model. Panel data models allow us to incorporate more information as we can include the time series data for both: (a) those service for which we introduced a minimum standard, and (b) those for which we did not. The results of the model allow us to compare the evolution of Openreach performance for these different types of services.

3.57 A main advantage of the panel data model is that it takes account of any potential 'unobserved factors' that may have had an impact on Openreach's performance, but which are not captured in the time series analysis. The model does this by assuming that any unobserved factors have impacted on both the products regulated by the QoS intervention and those products which were not regulated by the QoS intervention.

3.58 If this assumption is true, then the panel data estimates of the impact of the QoS intervention on Openreach's service levels accounts for all other relevant factors.

3.59 A disadvantage of the panel data analysis is that we cannot estimate the impact of the QoS intervention for each product-care level combination. Instead, we estimate the average impact of the QoS intervention across all products (WLR - SML1, WLR - SML2, MPF - SML2, GEA-FTTC - SML2) and all time periods (August 2014 – December 2019).

3.60 In the next subsection we provide the main results from the panel data model. More details are included in Technical annex (paragraphs A1.64 to A1.72).

Results

3.61 The main results of the panel data modelling are that, every time we raised minimum standards, the increase in Openreach's performance was between 2 percentage points and 3.2 percentage points[51] – with an average net impact of 2.6 percentage points.[52] This means that the performance of services which had service quality regulated by the QoS intervention increased by 2.6 percentage points more than services for which we did not introduce minimum standards. The model shows that this result is statistically significant.

3.62 The model also shows that our intervention did not have a significant effect on Openreach's performance from April 2015 to March 2016 when compared to the previous period (August 2014 to March 2015). However, as we raised the standards, their impact on KPIs became positive and statistically significant.

3.63 Unlike the time series model, the panel data model also takes account of technological developments, such as learning by doing, business, and operational efficiencies. The model suggests that rainfall (and the related increase in volumes) had a statistically significant impact on Openreach's performance and that technological development did not have an impact on the performance.

Installation service levels

Trend analysis

3.64 Similar to the trend analysis for repairs KPIs (paragraphs 3.10 to 3.21), we use the time-series data described in Technical annex to assess service level trends over time for installation KPIs (first available dates (FADs) and installations).

3.65 Our trend analysis for FADs and installations is analogous to the analysis for repairs in paragraphs 3.13 and 3.19. In what follows we summarise the main findings.

Results

FAD

3.66 The performance for FAD has improved significantly over the reference period, increasing:

a) from 95% (August 2014 – March 2015) to 99% (April 2019 – December 2019) for WLR; and

b) from 96% (August 2014 – March 2015) to 99% (April 2019 – December 2019) for MPF.

3.67 We also note that the reliability of the service provided by Openreach – measured in terms of volatility – improved markedly over the same period.

[51] Range provided at 95% confidence level.
[52] We do not compare panel data results with the time series results as doing so is not possible. Both approaches, however, provide very similar results.

3.68 However, performance measured in terms of average KPIs did not improve following the introduction and the subsequent two changes in the minimum standard. This was, at least in part, because the initial minimum standards were set at a level which was not intended to be stretching in the initial years.

3.69 The 2014 FAMR explains that, if Ofcom were to raise the minimum standards very quickly, Openreach would not have time to restructure and increase resources so that it could meet the required performance.[53] This led Ofcom to conclude that a more gradual increase in minimum standards was warranted.

3.70 Performance decreased in the period April 2016 to March 2018.[54] Having said that, performance was consistently and significantly above the QoS intervention minimum standards over the entire period.

Installations

3.71 Provision of WLR services was punctual 94% of the time before April 2018 and 95% of the time after we increased the QoS minimum standard. The same KPI for MPF was 94% both before and after we increased the QoS intervention minimum standard. Service reliability was relatively high (as measured by volatility, which was relatively low, at around 1%) both before and after April 2018 and for both WLR and MPF services.

Overall findings

3.72 Overall, our trend analysis indicates that Openreach's performance for FADs, installations and repairs seems to be linked to the minimum standards set by Ofcom: an increasing minimum standard is generally accompanied by an improved performance, if the standard is sufficiently stretching, i.e. if it is not too far from the current performance level.[55]

3.73 The graphical comparison of trends in KPIs for repair services regulated by the QoS intervention and those not regulated by the intervention, tends to support this conclusion.

3.74 Our econometric analysis specific to repair services also shows that:

a) quality of services on which we imposed minimum standards has improved in almost all cases;

b) quality of services has improved as minimum standards were raised and there is a statistically significant relationship between our QoS intervention and the observed performance;

Ofcom, 2014. *Fixed Access Market Review 2014*, volume 1, paragraph 11.267.

[54] We understand that [✂].

[55] For all services subject to our minimum standards KPIs have increased, with the exception of installation – where MPF services present a marginal decrease. For these, however, the performance was high in August 2014 and the current performance is still significantly above our regulatory threshold.

c) quality of services for which we did not impose minimum standards did not improve over time, supporting the view that the observed improvements are a result of our policy; and

d) service improvements appeared only when minimum standards became more stretching. By contrast, when minimum standards were set significantly below the existing observed performance, Openreach performance did not improve and actually slightly decreased in terms of reliability.

4. Stakeholder views

Introduction and summary

4.1 To further inform our analysis we sought the views of stakeholders – including Openreach, telecoms providers and trade bodies – on the effectiveness of our QoS intervention.[56] In general, the views of stakeholders corroborated the results of our quantitative analysis. We gathered these views through a series of meetings and calls in which we explored stakeholders' perspectives on:

a) the overall impact of the QoS intervention on Openreach's performance;

b) the factors which affect Openreach's performance including factors apart from the QoS intervention which may have contributed to the observed improvements, e.g. other industry or technological developments that may have had a positive impact on Openreach performance;

c) any unintended consequences from the QoS intervention; and

d) any other dimensions of the intervention design that we should consider when evaluating the impact of our intervention on Openreach's performance more holistically.

4.2 In this section we first report what stakeholders said about the level of resources that Openreach devotes to installation and repair services and how this is related to Openreach's performance (paragraphs 4.4 to 4.7). In doing so they confirmed that, absent our intervention, Openreach's performance would not have improved (paragraphs 4.7 to 4.20).

4.3 In the last part of this section we then report what stakeholder told us on other factors that may affect Openreach's performance (paragraphs 4.21 to 4.31) and their views on other potential implications and the design of our intervention (paragraphs 4.32 to 4.44).

Overall impact

More resources lead to better performance

4.4 All stakeholders told us that the key driver of Openreach's performance is the quantity and quality of resources Openreach devotes to installations and repairs. We understand that the main resource is labour and therefore the level of field staff (i.e. technicians and engineers) that Openreach can devote to installation and repair services is one of the main drivers of service quality. It also enables Openreach to deal with above average demand for these services (such as during periods of bad weather).

[56] These include [✂].

4.5 For example, as many stakeholders explained, Openreach's poor performance at the beginning of the last decade (especially for WLR and MPF repairs) was because Openreach did not have sufficient staff to cope with the demand for repairs and installations.[57] The decline in Openreach's performance was particularly significant for repairs. Installations were also affected, but to a much lesser extent.[58]

4.6 Stakeholders noted that Openreach's performance recovered – concurrently and following Ofcom's intervention – when Openreach increased the number of skilled and well-equipped technicians, i.e. engineers with the required set of skills. Some stakeholders explained that improved performance was also due to Openreach's efforts to increase the number of multi-skill technicians – their use can be more flexible as they can be allocated to different services as and when required. Openreach also improved its fault diagnostics, which led to engineers with the right set of skills being dispatched to jobs more quickly.

Counterfactual

4.7 As mentioned in paragraph 4.1, a key objective of our engagement with stakeholders was to establish whether the observed changes in Openreach's effort and performance, in whole or in part, are attributable to our intervention.

4.8 In principle, it is possible that the observed changes would have occurred absent our intervention. For example, the observed improvement in Openreach's performance could have been due to external factors such as technological developments which are independent of our intervention. Similarly, Openreach could have decided to hire additional engineers and devoted more resources to the services concerned even absent our intervention.

4.9 In this subsection we provide stakeholders' views on (a) whether Ofcom's intervention led to improved service levels, and (b) other factors which impact on Openreach's performance.

Necessity of Ofcom intervention

4.10 There was consensus among stakeholders that our intervention was necessary since – to quote one key stakeholder – *"the intervention has strengthened Openreach's incentive to devote resources to installations and repairs"*.[59]

4.11 Some stakeholders explained that prior to our intervention industry had made a few attempts to address the issue.[60] However, none of these proved to be successful. For example, one stakeholder explained that *"Before Ofcom's intervention there was nothing that CPs could do to compel Openreach to improve its performance. It then became clear that regulatory intervention was necessary. Indeed, when Ofcom acted the improvement*

[57] [✂].
[58] [✂].
[59] [✂].
[60] [✂].

started to happen". For the same reasons another stakeholder explained that "*Ofcom intervention was necessary to solve the service crisis*".

4.12 Prior to 2014, industry introduced SLA/SLG contract requirements. As part of these agreements, Openreach agreed to compensate retail providers when it failed to deliver services.

4.13 In addition, Ofcom regulated certain aspects of Openreach's conduct, such as regulatory obligations for transparency and non-discrimination (i.e. equivalence of inputs).[61] These aimed to incentivise service quality and drive up Openreach's performance across regulated products.

4.14 However, stakeholders explained that such industry developments did not prove to be enough on their own. Ofcom's intervention in 2014 was essential to incentivise Openreach to improve staffing levels.

4.15 One stakeholder noted that, prior to 2014, Openreach was required to compensate telecoms providers for delays in provisions and repair interventions. However, compensation was on a per event basis.

4.16 Stakeholders advised that they believed Openreach would compare the costs and the benefits of meeting existing SLAs and SLGs and would make decisions on the optimal level of resources to allocate to these depending on the circumstances. The stakeholders view was that, beyond a compliance level, it was more profitable to pay compensation than to provide the service according to the SLA/SLG.[62]

4.17 The 2014 intervention introduced a 'double lock': it confirmed the per event compensation and introduced the potential of a penalty of up to 10% of BT's relevant turnover in the case of missed targets.[63] Some stakeholders advised that this radically shifted Openreach's incentives.

4.18 Consistent with Ofcom's expectations in the 2014 FAMR – see paragraphs 2.27b) and 2.27c) in this report – the same stakeholder explained that:

a) the potential of a financial penalty was a strong incentive per se; but

b) the intervention also introduced a risk of reputational damage to Openreach. The stakeholder advised that, if Openreach was unable to meet the minimum standard, this could be reported by the news media and impact on BT's share price.

4.19 Similarly, another stakeholder confirmed that, with the introduction of minimum standards, Openreach started monitoring its performance more carefully and started recruiting additional engineers. This stakeholder explained that *"when the regulator looks*

[61] Openreach provides products and services to telecoms providers on an 'equivalent' basis. This obligation is embodied in the BT Undertakings given to Ofcom in September 2005.
[62] Analysis performed as part of the 2014 FAMR also demonstrates this. Ofcom, 2014. *Fixed Access Market Review 2014*, volume 1.
[63] Ofcom, 2017. *Enforcement guidelines for regulatory investigations*. Ofcom, 2017. *Penalty Guidelines for more information*.

into certain issues you can be sure that [the relevant] market players will change their behaviour to make the regulator happy. Knowing that they were under Ofcom's scrutiny Openreach devoted more resources to avoid getting into further troubles".[64]

4.20 According to stakeholders, the intervention introduced reputational risk for Openreach/BT and its management that previously did not exist. Stakeholders believed that Openreach's senior management would need to take this risk into account when considering the costs and the benefits of delivering services on time. To quote one of the stakeholders "*this was a real game changer*".[65]

Factors that affect Openreach performance

4.21 In this section, we set out the factors, identified by stakeholders, which impact on Openreach's service performance. These are the factors that we also considered in our econometric modelling. Taking these into account, both quantitively and qualitatively, provides an objective basis to assess the impact of QoS minimum standards on Openreach relevant KPIs.

Weather-related conditions

4.22 There was consensus among stakeholders that exceptional weather conditions can affect Openreach performance.[66] This also explains existing regional differences.[67]

4.23 Stakeholders explained that exceptional weather conditions – e.g. heavy rain and floods – represent a significant contributory factor causing faulty landline and broadband services. The number of interventions (i.e. repairs) requested by retail providers and their end users generally increases significantly during periods of poor weather. In this regard, it is worth noting that in some regions (e.g. Wessex[68] and Scotland) the weather conditions are more challenging than in others.

Urban and rural areas

4.24 Stakeholders explained that, typically, it can be more challenging to repair services in rural areas than in urban areas. This is because the longer lines involved make it harder to identify where the fault is. For the same reason, engineering journeys to provide repair services typically take longer on average.

4.25 The difference is not so clear-cut for installations. Their provision can be more challenging in rural areas due, again, to the potential length of lines and the increased likelihood of civil

[64] [✂].
[65] [✂].
[66] [✂].
[67] [✂].
[68] This is an Openreach region title.

works. However, there are also challenges in urban areas where the need for civil works, wayleaves, traffic management and so forth can also cause significant delays.

Impact of technological change

4.26 Stakeholders had mixed views on impact of technology.

4.27 Some stakeholders explained that, in their view, no relevant, meaningful technological change took place in the industry during the period August 2014 – December 2019.[69]

4.28 Other stakeholders, however, mentioned the GEA-FTTC roll out as a major change to the network operated by Openreach.[70] However, they also explained that the net impact on service quality was unclear, especially during the roll out phase.

4.29 One stakeholder explained that, in principle, Openreach should have become more efficient due to 'learning by doing' efficiencies (i.e. technology). The stakeholder explained that Openreach probably scaled up and improved their understanding and ability to deliver these services. This stakeholder identified, by way of example, that the use of systems has helped Openreach to anticipate demand from customers. This, in turn, could have improved Openreach's performance.

4.30 Many stakeholders noted that, every time a major industry development takes place, Openreach performance is affected. For example, every time there is a new network build – such as the roll out of GEA-FTTC – Openreach will divert resources normally devoted to installations towards the new network build.[71]

4.31 Apart from potential technological changes, stakeholders did not mention any other developments that may have occurred in the industry and influenced Openreach ability or incentives to deliver repair and installation services on time.

Unintended consequences

4.32 As mentioned in Section 3, we asked stakeholders if there were any unintended consequences from our intervention. In what follows we report some potential issues raised by stakeholders.

Waterbed effect

4.33 Some stakeholders explained that Openreach may have had the incentive to divert resources from care levels 3 and 4 (not regulated by the QoS intervention) in response to Ofcom's focus on care levels 1 and 2 (which were regulated by the QoS intervention).[72] However, stakeholders were unable to provide evidence for this proposition.

[69] [✂].
[70] [✂].
[71] [✂].
[72] [✂].

4.34 We note that volumes for care levels 3 and 4 are particularly low. Therefore, the level of resources that Openreach would be able to redeploy would be negligible. In addition, these services are more profitable to Openreach than care levels 1 and 2. This tends to indicate that Openreach had no reason to decrease its performance in unregulated services. We note also that performance for these has not decreased over time (as shown in Section 3).

Reduced incentives to overperform

4.35 Some stakeholders mentioned that, by setting a minimum standard, Openreach may have had an incentive to meet the minimum standard but not to perform much better than this. In this case, Openreach would not have the incentive to go beyond that threshold since doing so would be costly and not required by the regulator.[73]

4.36 However, we note that the time series trends in Figure and Figure show that Openreach has outperformed the minimum standards since the QoS intervention began.

Demand induced by the regulator

4.37 One stakeholder explained that Ofcom's decision not to introduce remedies for care levels with relatively low demand (i.e. SML3 and SML4) may have generated a 'vicious circle'.

4.38 The stakeholder's view is that minimum standards for some care levels and not others, reduces the incentive to provide high levels of care for the services without minimum quality standards.

4.39 We note that there is no evidence that customers have switched in large numbers in the way described above.

Intervention design

4.40 We asked stakeholders to provide feedback on the way our regulatory action was designed and implemented. The objective was to understand what went well and what we could have done better as we intervened to drive up Openreach performance.

4.41 All stakeholders advised that our intervention increased market transparency. Minimum standards and regular reporting of KPIs enable telecoms providers (and Ofcom) to raise their concerns more effectively. As explained in paragraphs 4.19 - 4.20, the QoS intervention introduced incentives and enhanced the reputational risk for Openreach.

4.42 Many stakeholders – especially the retail providers – believe that our intervention could have been more ambitious in the earlier years. They explained that the thresholds we introduced initially were not sufficiently stretching and, as a consequence, did not really induce Openreach to improve its performance.[74]

[73] [✂].
[74] [✂].

4.43 Nevertheless, from the outset Ofcom was aware that the initial standards were not particularly challenging. The 2014 FAMR explains that, if Ofcom were to raise the minimum standards very quickly, Openreach would not have time to hire a sufficient number of additional engineers. Moreover, it would have had to use more expensive contractors. This led Ofcom to conclude that a more gradual increase in minimum standards was warranted.

4.44 Some stakeholders – especially the retail providers – noted that in addition to Openreach's ability to deliver installations and repairs on time (provisions and repairs), Ofcom could have considered the entire customer experience and other potential causes of consumer harm. This is because not only the punctuality but also the quality of the work delivered by Openreach is important. For example, Ofcom could have introduced regulation also on the number of faults that take place within 28 days from installation (early life faults) and within 28 days of a repair (repeat faults). By not doing so Openreach is incentivized to focus resources on timeliness at the expense of quality. However, having customer data for the period 2012 to 2017 we found that performance of early faults and early repeated faults did not decrease after our intervention.

Overall findings

4.45 In summary, the stakeholders we spoke to explained that:

a) the level of resources (i.e. relevant staff such as engineers) that Openreach can devote to installation and repair services is the main driver of Openreach's service level performance;

b) Ofcom's intervention was a key catalyst for the various changes that Openreach put in place to improve its performance;

c) the intervention introduced financial and reputational incentives that induced Openreach to invest in more resources and to improve its operational process; and

d) reputational incentives, in particular, generated a cultural shift within Openreach.

A1. Technical annex

Introduction and summary

A1.1 This annex provides additional detail on our analysis to measure the impact of the QoS intervention on Openreach's service level performance.

A1.2 This annex includes details of the econometric analysis illustrated in section 3. The analysis intends to estimate the magnitude of the impact of the QoS intervention on Openreach's performance in a way that controls for other factors that may have influenced this. We find that the QoS intervention had a statistically significant, positive impact on Openreach's service level performance.

A1.3 This annex is structured as follows:

a) first, we describe the data;

b) second, we present summary statistics and trend analysis that complement our findings in section 3;

c) third, we provide a detailed description of our econometric analysis of repair services. In doing so we set out our main empirical results including robustness checks.

Data

Openreach monthly reporting

A1.4 The QoS intervention and subsequent reviews require Openreach to report to Ofcom monthly installation and repair KPIs. We have gathered monthly data on a number of services and related care levels (where applicable). For most of these we have data since August 2014, but for others we have data since August 2018.[75]

A1.5 For each of the service and care levels listed below, the monthly datasets (i.e. the data that we use for this annex) include data on:

a) year and month;

b) monthly KPI levels related to wholesale service (e.g. the proportion of installations and repairs delivered on time for WLR, MPF, GEA-FTTC, GEA-FTTP, ISDN2, ISDN30, and SMPF services);

c) the repair care level (i.e. SML1, SML2, SML 2.5, SML3, SML4);

d) total number of telecoms providers' requests to repair a fault (repair requests) or install a line in any given month for each type of service and for each care level;

[75] For GEA-FTTC installations and WLR - SML 2.5 repair services we only have data since April 2018.

e) total number of requests met within contractually agreed times in any given month for each type of service, and for each care level (applicable only to repairs);

f) proportion of total number of requests met within contractually agreed times for each type of service, and for each care level (applicable only to repairs) in any given month; and

g) monthly average waiting times, i.e. the number of days (for installations) and hours (for repairs) that it took Openreach to complete the orders once the request has been submitted by the telecom provider.

Data management and preparation

A1.6 After an initial review of Openreach's data, we:

a) reviewed and assessed the quality of the data;

b) dropped data for services for which we do not have relevant information for the entire reference period (i.e. August 2014 to December 2019);[76]

c) added monthly data on rainfall in the UK for the entire reference period assessed;

d) calculated monthly volumes for all requests to repair services from telecoms providers in any given month ('repair request volumes') - to do so we added up repair requests for all services and for all care levels included in the regulatory reporting data;

e) added a time trend designed to capture the effect of time (which may be a proxy for the impact of technological changes, other regulatory changes, and other common trends – if any – common to all services);

f) added monthly rainfall data;

g) added monthly seasonal variables to proxy for other seasonal effects that may occur annually in addition to rainfall; and

h) added a categorical variable with values from 1 to 5, one for each time the standard increased – this captures the average impact of our QoS intervention as we raised the minimum standards over time.

Summary statistics and trend analysis

Comparing KPIs at the beginning and at the end of the reference period

A1.7 We used the data to compare service performance levels (as measured by KPI levels) shortly after the QoS intervention was introduced with current installation and repair service levels. In this subsection, we compare service levels in the most recent period available and the period immediately after the intervention. By doing so, we compare Openreach performance in two comparable periods in terms of duration, season and

[76] MPF - SML1, WLR - SML2.5, FTTC - SML4, FTTP - SML4, MPF - SML4, SMPF - SML4, WLR - SML4.

rainfall. The comparison provides useful indicative statistics to illustrate how Openreach performance changed over time.

A1.8 For repairs and installations (including FADs) we compare KPIs in the most recent period and immediately after the intervention using the following statistics:

e) average KPI levels, lowest service level in the period, and volatility in the service levels for KPIs which were within the contractually agreed period; and

f) average waiting times.

A1.9 In the following tables, green text indicates that the service level has improved when compared to previous levels, while red text indicates that the service level has deteriorated. Black text indicates that the service is unchanged.

Average service quality, lowest service quality and service reliability

A1.10 By comparing descriptive statistics of the KPI levels for WLR and MPF services during the first 6 months of the reference period (i.e. August 14 to January 15 – hereafter 'at the beginning of the reference period') with average KPIs at the end of the reference period (i.e. July 19 to December 19 – hereafter 'at the end of the reference period') we observe that quality of services provided by Openreach has improved in almost all cases.

A1.11 In what follows we compare installation service levels in the most recent period available to us with the period immediately after the intervention.

A1.12 The table below shows the average installation service levels, lowest service levels and volatility for first available dates and installations.

A1.13 A measure of 95% for installations, for example, means that 95% of installations were within the contractually agreed period. 95% for FAD, for example, means that 95% of first available dates offered to customers were within the contractually agreed period.

Table 4: Comparison of relevant installation KPIs at the beginning and end of the reference period

		Average service level		Lowest service level		Volatility	
Product	**Service**	**Aug14 to Jan15**	**Jul19 to Dec19**	**Aug14 to Jan14**	**Jul19 to Dec19**	**Aug14 to Jan14**	**Jul19 to Dec19**
WLR	**FAD**	95%	98%**	86%	93%**	4%	2%**
MPF	**FAD**	95%	99%**	87%	94%**	4%	<1%**
WLR	**Installation**	92%	94%**	92%	93%**	<1%	<1%
MPF	**Installation**	95%	94%*	94%	93%*	<1%	<1%

** - *improvement*

* - *deterioration*

Source: Ofcom analysis of Openreach regulatory reporting data.

Note: Volatility is measured as the standard deviation of monthly KPI levels over the relevant period.

A1.14 The table above shows that, for installation KPIs, when compared with the start of the reference period:

g) average repair service levels were higher for all regulated service levels except installation of MPF which decreased slightly (but by less than 1 percentage point);

h) the lowest service levels were higher for all regulated service levels except MPF installation which decreased slightly (but by less than 1 percentage point); and

i) the volatility of service levels decreased (or remained at 0%) for all regulated service levels, i.e. customers benefitted from greater certainty because of lower fluctuations in service levels.

A1.15 Our results indicate that the QoS intervention improved outcomes for Openreach's customers by leading to improved first-available-date and installation service levels and reducing volatility.

A1.16 At the end of the reference period Openreach almost always offered an appointment to install voice and broadband services within 12 days of a request, i.e. the contractually agreed period. This was not always the case at the beginning of the reference period.

A1.17 There was a marginal decrease in service levels for MPF installations. The original performance, however, was already high (well over 90%) and, throughout the period, remained well above the minimum threshold that we set in the QoS intervention (which was 89% by 2019).

A1.18 Below we compare repair service levels in the most recent period available to us and the period immediately after the intervention.

Table 5: Comparison of repair KPIs at the beginning and end of the reference period

		Average service level		Lowest service level		Volatility	
Product	**Service**	**Aug14 to Jan15**	**Jul19 to Dec19**	**Aug14 to Jan14**	**Jul19 to Dec19**	**Aug14 to Jan14**	**Jul19 to Dec19**
WLR	**SML1**	75%	83%**	73%	79%**	2%	2%
WLR	**SML2**	72%	81%**	67%	78%**	4%	2%**
MPF	**SML2**	74%	84%**	73%	81%**	1%	2%*

** - improvement

* - deterioration

Source: Ofcom analysis of Openreach regulatory reporting data.

Note: Volatility is measured as the standard deviation of monthly KPIs over the relevant period.

A1.19 The above table shows that, when compared with the start of the reference period:

a) average repair service levels were higher for all regulated services;

b) the lowest service levels were higher for all regulated service levels; and

c) the volatility of service levels decreased for WLR SML2 (i.e. customers benefitted from greater certainty because of lower fluctuations in service levels), was static for WLR SML1 but slightly increased MPF SML2.

A1.20 The results presented above indicate that the QoS intervention improved outcomes for Openreach's customers by leading to improved repair service levels and reducing volatility. The increase in volatility for SML2 for MPF is relatively small (at around 1 percentage point).

Average customer waiting times

A1.21 The table below shows the average customer waiting times for repairs at the start of the reference period and at the end of the reference period. Waiting time is the duration between the time a customer requests a service and the time it is delivered.

A1.22 The table shows the average waiting time in hours for WLR with the SML1 service level, WLR with the SML2 service level, and MPF with the SML2 service level.

Table 6: Comparison of average waiting times for repairs at the beginning and end of the reference period (hours)

Product	Service agreement	Aug-Jan15	Jul-Dec19
WLR	SML1	35.30	31.80**
WLR	SML2	30.26	24.00**
MPF2	SML2	25.82	24.41**

*** - improvement*

Source: Ofcom analysis of Openreach regulatory reporting data.

A1.23 The table above shows that, when compared with the end of the reference period, average customer waiting times for repair services have decreased (i.e. that service improved) for all services and all service agreements.

A1.24 The table below shows average customer waiting times in days for first available dates and installations at the start of the reference period and at the end of the reference period.

Table 7: Comparison of average waiting times for installation KPIs at the beginning and end of the reference period (days)

Product	Service	Aug-Jan15	Jul-Dec19
WLR	*FAD*	8.3	7.6**
MPF	*FAD*	8.2	6.4**

WLR	*Installation*	11.1	11.1
MPF	*Installation*	11.2	10.6

** *- improvement*

Source: Ofcom analysis of Openreach regulatory reporting data.

A1.25 The table above shows that, when compared with the end of the reference period, average customer waiting times for first available dates and installations have decreased (i.e. that service improved) for most services and service agreements. The exception is installations for WLR services which were unchanged when we compare the average customer waiting times at the beginning and end of the reference period.

Econometric models

A1.26 For data availability reasons, our econometric analysis focuses on repair services. Unlike for installation services:

a) There are Openreach repair service care levels which are regulated by the QoS intervention and service care levels which are not regulated by the QoS intervention.

b) Combining the data on Openreach's performance for regulated and unregulated repair service care levels allows us to use statistical techniques to isolate the impact of the QoS intervention on Openreach's service levels.

A1.27 In our analysis we use time series data and panel data models. We describe these models in the next section.

Time series models

A1.28 Our time series analysis aims to understand whether there is an economically (i.e. not small in magnitude) and statistically significant relationship between our minimum standards and their increased levels over time on Openreach performance (i.e. KPIs) for services for which we introduced minimum standards.

A1.29 For this analysis, we considered six different time series datasets containing monthly information for five different combinations of services and care levels (i.e. WLR - SML1, WLR - SML2, WLR - SML3, MPF - SML2, MPF - SML3. These are subsets of the data described above (see Data sub-section). Each of these datasets includes relevant monthly information on i) Year and Month; ii) Proportion of total number of requests met within contractually agreed times; iii) rainfall volumes (mm); iv) volumes for all requests to repair services ('repair request volumes'); and v) seasonality dummies.

A1.30 We want to assess the impact of our QoS intervention on Openreach performance in any given month. To do so we use time series static models. "Static" models are used to

estimate a contemporaneous relationship between a dependent variable (i.e. Openreach KPI levels) and a variable of interest (i.e. our QoS intervention).[77, 78]

Robustness checks

A1.31 Our static models measure the statistical significance of the relationship between the minimum standards in the QoS intervention and Openreach's KPIs for services for which we introduced minimum standards. However, since other factors, unrelated to our intervention ('confounding factors'), could have caused the improvement in Openreach's KPIs, we need to test this possibility.

A1.32 We test for this by reproducing our static models for two more combinations of service and care levels (i.e. WLR - SML3, and MPF - SML3) for which we did not introduce minimum standards. These are referred to as 'placebo' models.

A1.33 We can compare the increase in service levels caused by the QoS intervention in our time series models with the increase in service levels ascribed to the confounding factors in the placebo models. The difference between the two, i.e. service improvement in unregulated services and service improvement in QoS regulated services, is the level of service improvement which can be ascribed to the QoS intervention.

A1.34 The placebo variable is a categorical variable with values from 1 to 5, one for when the standard is first introduced and increasing for every time the standard increased, i.e. August 2014 to March 2015, April 2015 to March 2016, April 2016 to March 2018, April 2018 to March 2019, and April 2019 to December 2019.

Panel data model

A1.35 We use a pooled cross-section dataset to estimate the panel data model. Specifically, we estimate a random effects model.

A1.36 The pooled cross-section dataset contains monthly time series data for all combinations of repair services and care levels included in Openreach regulatory reporting data and for the period for which we have data (August 2014 to December 2019). This means that, in addition to the above-mentioned services, the dataset includes time series data for other services over the period August 2014 to December 2019.[79] We do not have data for the entire period for MPF - SML1, WLR - SML2.5, FTTC - SML4, GEA-FTTP - SML4, MPF - SML4, SMPF - SML4, WLR - SML4. These services are therefore omitted from the analysis.

A1.37 We can use the natural variation created between different types of services, i.e. combinations of services and care levels for which we introduced a minimum standard (treated services) and combinations for which we did not do so (untreated services). Such

[77] More generally, a static model is postulated when a change in the variable of interest at time is believed to have an immediate effect on the dependent variable.
[78] For further information on static time series models see JM Wooldridge, 2003, *Introductory Econometrics*, second edition, Chapter 10, p313.
[79] GEA-FTTP - SML2, GEA-FTTP - SML3, ISDN2 - SML2, ISDN2 - SML3, ISDN30 - SML2, ISDN30 - SML3, SMPF - SML2, SMPF - SML3.

variation will enable us to assess the impact of our regulatory intervention over time on relevant outcomes (i.e. KPIs) for the treated services (or treatment group) relative to the untreated services (or control group).

A1.38 To do so we use information on outcomes (i.e. KPI levels) for the control and treatment services in different periods of our intervention to take account of systemic differences between the treated and the control groups. We compare the difference in outcomes between the treatment and control groups in every period. This gives us the impact of our regulatory intervention.

A1.39 The use of this methodology relies on one main identifying assumption: there are common trends between the control group (in this case unregulated services) and the treatment group (in this case services subject to the QoS intervention minimum service levels) in the absence of treatment (i.e. in the absence of the QoS intervention), and that these have not changed during the intervention period.

A1.40 In other words, our analysis assumes that the trends for the KPI levels of the treated services would have followed the trends for the KPI levels of the control group, had we not intervened.

Empirical results of econometric modelling, including robustness checks

Time series models

A1.41 In this subsection, firstly we present the results and interpretation of our static time series models for WLR - SML1, WLR - SML 2, and WPF - SML2. We then provide the results and interpretation of our placebo models for WLR - SML3 and MPF -SML3.

Static model: repairs WLR - SML1

A1.42 To model the contemporaneous relationship between our minimum standards and Openreach performance first we estimate a univariate time series model ('Model 1' in Table 10), i.e. a model with only one variable (our QoS intervention). In subsequent models, we then add additional variables which stakeholders identified as potentially impacting on Openreach's service level performance. These variables are: seasonality dummies, and data on monthly volumes and rainfall. Explanatory variables included in throughout the various model specifications are described in Table 8 below.

Table 8: Explanatory variables and relevant descriptions

Explanatory variables	Description
QoS min standards (over time)	Coefficient describing average impact of QoS minimum standards on Openreach performance every time these have increased

Multiple period dummy variables (see paragraph A1.47)	Multiple coefficients describing individual impact of each increase in the minimum standards: • Period 1 – Aug 2014 to March2015; • Period 2 – Apr 2015 to March 2016; • Period 3 – Apr 2016 to March 2018; • Period 4 – Apr 2018 to March 2019; • Period 5 – Apr 2019 to Dec 2019.
Monthly seasonal variables	Multiple coefficients describing potential seasonality (monthly) effects
Rainfall (mm)	Coefficient describing average impact of an increase in rainfall by 100mm
Repair request volumes (all products)	Coefficient describing average impact of an increase in repair incidents by 50,000 units

A1.43 Explanatory variables included in each model specification are described in Table 9 below.

Table 9: Explanatory variables included in different model specifications

Model	Explanatory variables
Model 1	QoS minimum standards (over time)
Model 2	Multiple period dummy variables
Model 3	QoS minimum standards (over time); Rainfall (mm)
Model 4	QoS minimum standards (over time); Repair requests volumes
Model 5	QoS minimum standards (over time); Repair request volumes (all products); Rainfall (mm)

A1.44 The progressive addition of these variables can be seen in Model 2 – Model 6 in the below table. In model 3 we control for potential seasonality effects. Models 4 to 6 control for the impact of rainfall and repair request volumes.

A1.45 Table 10 below provides our results for each of models 1 to 6, including the statistical significance of each of the variables in the models.

Table 10: Impact of minimum standards on performance of WLR - SML1[80]

Variables	(1) On time (%)	(2) On time (%)	(3) On time (%)	(4) On time (%)	(5) On time (%)
Period 2		-0.00391			
		(0.0143)			
Period 3		0.0657***			
		(0.0128)			
Period 4		0.0906***			
		(0.0143)			
Period 5		0.0863***			
		(0.0153)			
QoS min standard	0.0281***		0.0261***	0.0254***	0.0254***
	(0.00369)		(0.00314)	(0.00342)	(0.00315)
Rainfall			-0.0521***		-0.0422***
			(0.0101)		(0.0122)
Repair request volumes				-0.0301***	-0.0126
				(0.00789)	(0.00887)
Constant	0.723***	0.756***	0.780***	0.906***	0.846***
	(0.0120)	(0.0111)	(0.0150)	(0.0493)	(0.0487)
Observations	65	65	65	65	65
R-squared	0.479	0.608	0.635	0.578	0.647
Adjusted R-squared	0.471	0.582	0.624	0.565	0.630

Notes: Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Ofcom analysis of Openreach regulatory reporting data.

A1.46 Model 1 in Table 10 shows that every time we raised minimum standards Openreach performance for the WLR – SML1 product increased, on average, by 2.8 percentage points.[81] The model also shows that the estimate is statistically significant, i.e. is not the result of a chance correlation in the data.

A1.47 We then include dummy variables for each time we raised the standard. This approach allows us to verify whether and to what extent Openreach's performance changed in response to each increase in the service level standards.

A1.48 Model 2 in Table 10 shows that our minimum standards did not have a meaningful impact on Openreach performance in the period April 2015 to March 2016 relative to the preceding period, i.e. August 2014 to March 2015. This is consistent with our findings in Section 4 and confirms stakeholder feedback that our minimum standards were not particularly stretching at the beginning of the reference period but became stretching as the minimum standards increased.

A1.49 From the same model, Model 2, we observe that our minimum standards subsequently (i.e. from April 2016 to March 2018, April 2018 to March 2019 and April 2019 to December

[80] Estimated coefficients are from linear regressions.

[81] In the table this is 0.0281 which we have converted to percentage points.

2019) had a positive and statistically significant impact on the relevant KPI. Therefore, the impact was larger for higher standards, suggesting that when standards became more stretching Openreach devoted more efforts to improve its performance.

A1.50 Finally, also based on stakeholder feedback, we added other factors that may have had an impact on Openreach performance over time:

a) potential seasonality effects;

b) the impact of rainfall; and

c) repair request volumes (all products).

A1.51 Our regressions also show that there is no additional seasonality impact on the relevant KPI.

A1.52 Models 3 to 5 confirm that a high demand for repairs services – which generally corresponds to periods of increased rainfall – has a negative impact on Openreach's performance.

A1.53 The impact of volumes of repair requests is particularly important. As we add (i.e. control for) volumes, we find that not all of the observed improved performance was due to the QoS intervention. Instead, some of the improvements in service levels can be attributed to a reduction in repair request volumes i.e. assuming that Openreach's repairs capacity is fixed in the short-run, fewer requests for repairs mean that the requests it receives can be dealt with more quickly.

A1.54 Model 5 shows our results when we control for all of the factors described above. Overall, we find that, every time we raised minimum standards, Openreach performance for WLR – SML1 products increased on average by 2.5 percentage points. It is worth noting that the adjusted R-squared shows that around 63% of Openreach performance is explained by our model. It follows that the model explains a relatively high proportion of Openreach performance. The F-test (not shown in the table) shows that the explanatory variables included in the model are jointly significant at any level of statistical significance.

A1.55 In the next subsections, we replicate this analysis for WLR-SML2, MPF-SML2, MPF – SML3, and WLR – SML3.

Static model: repairs WLR-SML2 and MPF-SML2

A1.56 Our findings for the WLR – SML2 product are similar. As expected, we observe a statistically significant relationship between our minimum standards and Openreach performance. Every time we raised the minimum standards for WLR-SML2 and MPF-SML2 the relative performance improved – on average – by 3.4 percentage points and by 2.9 percentage points respectively.

A1.57 We also find that the impact of our minimum standards was not statistically and economically significant at the beginning of the reference period but became significant starting from April 2016, i.e. when the standards became more stretching.

A1.58 Finally, rainfall has a negative impact on the relevant KPI levels. We find that the net impact of our intervention was on average (i.e. every time the standard increased) around 3.4%.

A1.59 Finally, the adjusted R-squared shows that our model explains a large proportion of Openreach's performance (i.e. 62%).

Placebo model: repairs WLR-SML3 and MPF-SML3

A1.60 The static models above show a statistically significant and positive relationship between our minimum standards and Openreach's performance. They also include additional variables affecting Openreach performance as suggested by stakeholders. However, in principle they might still fail to account for other unobserved and unknown factors which change over time and impact on Openreach's service performance but are unrelated to our intervention (although they account for some – for example, rainfall).

A1.61 We test for this by replicating our regressions above for products which were not subject to minimum service standards (i.e. WLR-SML3 and MPF-SML3). This means that we test for the relationship between the relevant KPI levels and placebo minimum standards. If a third factor were causing the changes that we see in our models above, we would expect the placebo minimum standards to have a statistically significant effect with a similar direction to our main findings.

A1.62 Our results show that the placebo minimum standard variables are not statistically significant and are very small for both WLR-SML3 and MPF-SML3.

A1.63 As expected, rainfall has a negative impact on Openreach performance for WLR-SML3 services. However, it does not seem to affect Openreach's performance for MPF-SML3.

Panel data analysis

A1.64 We also use a panel data model to help us identify whether the QoS intervention has led to changes in Openreach's service performance. We take advantage of our access to time series data for a cross section of observations (i.e. a panel data) including both those products for which we introduced a minimum standard and those products for which we did not introduce one. We then use a model that includes and compares Openreach performance for both those products included in the QoS intervention and those products that were not (i.e. treated and untreated products respectively).

A1.65 In our model we include all factors that stakeholders mentioned as potentially affecting Openreach performance (such as rainfall and repair request volumes). We cannot exclude, however, that there are other unobserved factors that may have affected Openreach performance as we raised the standards over time.

A1.66 This panel data analysis allows us to take account of unobserved factors that may have had an impact on Openreach performance. If these factors do not affect products regulated by the QoS intervention in a way that is different from their effect on products that are not regulated by the QoS intervention, our minimum standards variable should explain any

difference that we observe in the relative performance. That is, the minimum standards variable will isolate the impact of the QoS intervention on Openreach's performance.

A1.67 We illustrate the results of our panel data model in Table 11.

Table 11: Impact on products and services for which we introduced minimum standards[82]

Variables	(1) On time (%)	(2) On time (%)	(3) On time (%)	(4) On time (%)	(5) On time (%)
Regulated service	-0.0749***	-0.0367	-0.0638**	-0.0614**	-0.0617**
	(0.0289)	(0.0277)	(0.0293)	(0.0293)	(0.0293)
Period 2		-0.00363			
		(0.0223)			
Period 3		0.0709***			
		(0.0200)			
Period 4		0.0969***			
		(0.0217)			
Period 5		0.100***			
		(0.0229)			
QoS min standard	0.0310***		0.0266***	0.0262***	0.0260***
	(0.00502)		(0.00564)	(0.00564)	(0.00563)
Technology			0.00344*	0.00309	0.00325
			(0.00203)	(0.00204)	(0.00204)
Repair request volumes				-0.00993*	-0.00217
				(0.00544)	(0.00667)
Rainfall					-0.0186**
					(0.00930)
Constant	0.774***	0.774***	0.765***	0.824***	0.797***
	(0.0181)	(0.0182)	(0.0179)	(0.0368)	(0.0392)
Observations	934	934	934	934	934
Number of services	15	15	15	15	15

Notes: Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Ofcom analysis of Openreach regulatory reporting data.

A1.68 Model 1 in Table 11 shows that service levels for products subject to our intervention were worse than those which were not. The model also shows that every time we raised the minimum standards Openreach performance increased, on average, by 3.1 percentage points. This estimate is statistically significant.

A1.69 Consistent with our previous time series findings, Model 2 shows that the impact of the minimum standards was not significant initially. However, as we raised the standards their impact on KPIs was positive and statistically significant.

A1.70 In model 4 we add a time trend variable to capture the fact that, over time, Openreach performance may have improved due to technological developments such as the FTTC roll out and/or learning by doing effects. As this variable is not statistically significant, the

[82] Estimated coefficients are from linear regressions.

model suggests no other technological or regulatory changes had an impact on Openreach's performance over the period August 2014-December 2019.

A1.71 Model 5 shows our results when we control for all of the factors of interest, including repair request volumes and rainfall. This model confirms that repair request volumes are correlated with rainfall and that Openreach performance for repair services is negatively affected by this. Indeed, an in increase in rainfall of 100mm, on average, reduces Openreach's performance by around 1.9 percentage points. This negative impact on performance is consistent with stakeholder feedback.

A1.72 Overall, we find that that every time we increased the minimum standard for regulated services the relevant KPI levels increased by 2.6 percentage points.