Wholesale Local Access Market Review: Draft Statement

Annexes 10-16

[✂] Redacted for publication

DRAFT STATEMENT

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Contents

Annexes

A10. Service volume forecasts

A10.1 In this annex we explain the approach we have taken to forecast service volumes in the WLA and WFAEL markets.[1] Volume forecasts are important for setting charge controls because they impact costs in the following ways:

- The existence of fixed costs means that unit costs will increase if volumes fall and, conversely, decrease if volumes rise due to economies of scale and scope. Fixed costs are reflected in cost and asset volume elasticities in our top-down model (discussed in Annexes 11 and 18) and network dimensioning in our bottom-up model (discussed in Annexes 14 and 29).
- Shifts in demand (e.g. from copper services to fibre services) will result in changes to the mix of network components and potentially the cost profile of our modelled efficient operator.

A10.2 Our volume forecasts are used in our top-down and bottom-up models, as well as to support other analysis, for example, our WLR line forecasts are used as part of our common cost allocation (discussed in Annex 11). We also use the volumes forecast model to inform our market review decisions.[2] In our March consultation, we included forecasts up to 2028/29 as we were consulting on the appropriate approach to depreciation within the bottom-up model. Given the difficulties of forecasting over longer time horizons (particularly in light of the potential changes in the market) and our decision to use CCA depreciation for GEA (as set out in Annex 14), we have decided to no longer include volume forecasts beyond 2020/21.

A10.3 In Volume 2, Sections 2 and 4, we set out our reasoning and decisions for modelling an ongoing fixed network providing broadband and voice services, including fibre services to residential and business customers. We consider it appropriate to model an overlay fibre to the cabinet (FTTC) network on top of an ongoing copper network. We are using an anchor technology pricing approach meaning that we will treat all demand on the Openreach network as if it is served by connections either of copper only or a combination of copper and FTTC.

A10.4 There is always a degree of uncertainty when forecasting. In this case, the rate of migration from copper to fibre services is uncertain and is an important element for our forecasts. Another important element of our forecasts is the impact that competing networks will likely have on the number of Openreach lines over the charge control period.

A10.5 In the interest of transparency, we use publicly available data, where possible. In order to forecast service volumes, we have used the following sources of information:

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[1] We note that not all services within these markets will be subject to a charge control. However, we still need to forecast service volumes for services that are not subject to a charge control as they impact the calculation and allocation of fixed and common costs within these markets.

[2] For example, we have used the SMPF volume forecasts to inform our decision to remove the specific access obligation and charge control on SMPF and the GEA bandwidth forecasts to support our choice of an anchor product.

- Household forecasts from the Ministry of Housing, Communities and Local Government (MHCLG);[3] number of businesses from the Department for Business, Energy and Industrial Strategy (BEIS);[4] GDP forecasts from the Office for Budget Responsibility (OBR);[5] and market research commissioned by Ofcom.[6]
- Copper[7] and GEA[8] service volume data from BT for the financial years 2012/13 through to 2020/21 using our statutory information gathering powers, of which the final four years are forecast data.[9]
- Actual and forecast volumes provided by competitive network providers including Virgin Media, Hyperoptic, Gigaclear, [✂] and CityFibre/Vodafone.[10] We have used this data to forecast the impact that competitive networks will likely have on the number of purchased Openreach lines over the charge control period.
- Forecasts provided by downstream telecoms providers including BT, Daisy, EE, Plusnet, Sky, TalkTalk, and Vodafone. These forecasts are used to cross-check against our modelled forecasts, allowing us to test the robustness of our model and whether our modelling assumptions are reasonable.

A10.6 We consulted on possible approaches to forecasting service volumes in our March consultation. In reaching our decisions in this statement, we have updated our forecasts and our approach in light of stakeholder responses. We discuss our volume forecasts in more detail in our reasoning and decisions section of this annex. In summary, we estimate the following key trends over the charge control period:

- the total number of fixed line households will increase from 25 million to 26 million;
- the average number of Openreach lines per household will fall from 0.87 to 0.85;
- the total number of Openreach lines will fall from 25.1 million to 24.5 million;
- broadband penetration will increase from 80% to 86% of Openreach lines; and

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[3] MHCLG, 12 July 2016, Live tables on household projections.http://www.communities.gov.uk/housing/housingresearch/housingstatistics/housingstatisticsby/householdestimates/livetables-households [accessed 21 February 2018].

[4] BEIS, 30 November 2017, *Business population estimates 2017.* https://www.gov.uk/government/statistics/business-population-estimates-2017 [accessed 21 February 2018].

[5] OBR, 2017. *Economic and fiscal outlook – November 2017*. http://budgetresponsibility.org.uk/efo/economic-fiscal-outlook-november-2017/ [accessed 21 February 2018].

[6] Ofcom, various annual documents from 2011 to 2017, *The Communications Market Reports*. http://stakeholders.ofcom.org.uk/market-data-research/market-data/communications-market-reports/.

[7] Openreach response dated 13 September 2017 to question 2 of the 34th s.135 notice.

[8] Openreach response dated 13 September 2017 to question 2f of the 34th s.135 notice and Openreach's response 25 January 2018 to follow up on the 44th s.135 notice.

[9] In our volumes forecast model we have used the RFS and information provided directly by Openreach using our powers. The scope of the data captured is different from that published in Ofcom's telecommunications market data update table as the telecommunications table includes competitor's network infrastructure available in the UK (for example Virgin Media).

[10] We consider it likely that the impact of any additional future alternative network build (e.g. [✂]) will not be significant over the charge control period given the time it takes to deploy a network and to gain significant take-up. CityFibre response dated 1 December 2017 to question 1 and 2 of s.135 notice dated 8 November 2017. Hyperoptic response dated 8 December 2017 to question 1 and 2 of s.135 notice dated 8 November 2017. Gigaclear response dated 23 November 2017 to question 1 and 2 of s.135 notice dated 8 November 2017. Virgin Media response dated 31 January 2018 to question 6 of the s.135 notice dated 16 January 2018.

- the proportion of Openreach broadband lines that are GEA will increase from 33% to 61%.

A10.7 Table A10.1 below sets our estimates of out the impact of these forecast key trends on the main rental volumes. These forecasts are for the average number of lines in each year.

Table A10.1: Summary table of WLA and WFAEL rental volume forecasts

	2016/17 Actuals		2020/21 Forecasts	
	Number of lines (millions)	Share of all Openreach lines	Number of lines (millions)	Share of all Openreach lines
MPF lines[11]	7.2	29%	4.6	19%
WLR lines[12]	4.8	19%	3.4	14%
WLR + SMPF	6.3	25%	3.5	14%
MPF + GEA[13]	1.9	8%	5.1	21%
WLR + GEA[14]	4.8	19%	7.8	32%
Total Openreach lines	**25.1**		**24.6**	

Our proposals

A10.8 As part of our March consultation, we proposed the use of a volumes model to project volumes of WLR, MPF, SMPF, and GEA rentals, as well as their associated connections and ancillary services. We proposed to forecast service volumes using the following steps in our volumes model:

- **Step 1: forecast the number of fixed line UK premises:** including small and medium enterprises (SMEs) and households, but excluding mobile-only households.
- **Step 2: forecast the number of Openreach lines:** calculating the average number of Openreach lines per SME site and residential household, and multiply these by the BEIS business site forecasts and MHCLG fixed line household forecasts to estimate the number of future Openreach lines.[15] We proposed some adjustments to this forecast to account for the impact of the physical infrastructure access (PIA) remedy and future competitor network roll-out.

[11] Includes only MPF lines that are not purchased with GEA.
[12] Includes both residential and business lines that use WLR but not a SMPF or GEA line.
[13] Includes both GEA-FTTC and GEA-FTTP service volumes in 2016/17. The forecasts include use of G.Fast and SOGEA.
[14] Includes both GEA-FTTC and GEA-FTTP service volumes in 2016/17. The forecasts include use of G.Fast and SOGEA.
[15] BT's RFS based volume data does not differentiate between business and residential lines. We therefore split them into business and residential lines using the split at the overall industry level.

- **Step 3: forecast individual rental volumes:** we forecast broadband penetration and take-up of fibre services to estimate how our Openreach line forecasts are split between MPF, WLR, SMPF and GEA.
- **Step 4: forecast connection and ancillary services:** following our rental volume forecasts.

Stakeholder responses

A10.9 In this section we discuss stakeholder responses to our proposals. Our discussion is structured around the steps we proposed to forecast service volumes discussed above.[16]

The number of fixed line UK premises

Household growth

A10.10 Openreach considered dwelling growth more appropriate than household growth when forecasting fixed line households.[17] It believed that its concerns from previous responses were not addressed in our March consultation. These were that UK household growth has exceeded dwelling growth in the past seven years and in forecasts up to 2021. It recommended that we apply a dampening factor to the DCLG household growth forecasts, particularly in light of future economic uncertainty (e.g. Brexit).

Mobile only

A10.11 Openreach raised concerns about our forecasts of mobile-only households.[18] It highlighted the year-on-year decline in broadband net additions in Q1 and Q2 2017 and concluded that factors in the mobile market have driven this slowdown.[19] It cited an analyst report which indicated a total UK market slowdown in net additions and suggested mobile only as one cause.[20]

A10.12 TalkTalk supported our forecast that mobile-only would continue to decline over the charge control period.[21] It highlighted an increasing demand for bandwidth and the withdrawal of "all-you-can-eat" mobile offers. It believed this would more likely lead consumers to favour fixed line services in the future and view mobile as a complement to fixed line services.

[16] We did not receive any responses to our proposals regarding the forecasting of connection and ancillary services.
[17] Openreach response to the March 2017 WLA Consultation – Volume 2, Annex 4, paragraph 392.
[18] Openreach response to the September 2017 Consultation, paragraph 146.
[19] Specifically, BT highlighted rising fixed broadband prices, larger mobile data allowances and app-specific unlimited streaming allowances, also known as 'zero rated services' offered by some Mobile Network Operators (MNOs).
[20] Enders Analysis, "UK broadband, telephony and pay TV trends Q2 2017: Dead cat bounce?".
[21] TalkTalk response to the March 2017 WLA Consultation, paragraph 8.17.

The number of Openreach lines

Openreach lines per business site

A10.13 Openreach disagreed with our business line forecasts.[22] It believed the current trend of business line losses would continue to 2020/21, driven by growth in VoIP and line losses from multi-line premises. It recommended the removal of the 1.4 dampening factor on the growth in business lines that we used in our forecasts.

Competitive Network

A10.14 Virgin Media considered our forecast impact for PIA as conservative.[23] It referenced the Digital Communications Review, and noted that "Based on these estimates, it would be more than 70 years before the coverage target in the DCR is met".

A10.15 Openreach argued for an adjustment for the competitor network impact in addition to the adjustment made for Project Lightning.[24] It highlighted the announced rollout plans of Hyperoptic and CityFibre. It also specified that this adjustment should be made separate from the PIA adjustment to account for some competitor network build not using Openreach's infrastructure.

A10.16 TalkTalk recommended that we lower the forecast impact from Project Lightning.[25] It highlighted Virgin Media's quarterly results for premises passed have underperformed compared to expectations. TalkTalk also argued that PIA was unlikely to have a significant impact on Openreach volumes over the charge control period.[26]

A10.17 CityFibre argued that "Ofcom's model does not present the market as it exists today."[27] It considered that we underestimated existing and future competitive network build, highlighting that the model overestimated the reliance of competitor network build based on the PIA remedy.

Virgin Media non-Project Lightning impact

A10.18 Openreach was concerned about competitor impact from Virgin Media's non-Project Lightning network.[28] It highlighted KPI reports from both companies which indicated the decline in Openreach's broadband net additions and Virgin Media's gain in broadband net additions from 2014/15 to 2016/17. Openreach argued for a separate adjustment to be made for the competitor impact from Virgin Media's non-Project Lightning network, or for the forecast of Openreach lines per household to reflect its market position.

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[22] Openreach response to the March 2017 WLA Consultation – Volume 2, Annex 4, paragraph 403.
[23] Virgin Media response to the March 2017 WLA Consultation, paragraph 150.
[24] Openreach response to the March 2017 WLA Consultation – Volume 2, paragraphs 414-18.
[25] TalkTalk response to the March 2017 WLA Consultation, section 8.1.1.
[26] TalkTalk response to the March 2017 WLA Consultation, section 8.1.2.
[27] CityFibre response to the March 2017 WLA Consultation, paragraph 4.1.6
[28] Openreach response to the March 2017 WLA Consultation – Volume 2, paragraph 409.

Individual rental volumes

Broadband take-up

A10.19 Openreach agreed with our overall broadband penetration assumption but raised concerns with our assumption on fibre penetration.[29] In particular, it highlighted the forecast year-on-year increase in net additions for external GEA volumes. It recommended applying a dampening factor specifically to external GEA volume growth.

A10.20 Virgin Media considered our forecast fibre penetration assumption to be "aggressive" given that historical take-up may not be representative of future take-up.[30] It argued that previous migrations have been led by telecoms providers, rather than the consumer, and so historical take-up rates are unlikely to represent changes in consumer preferences.

55/10 to 80/20 migration

A10.21 TalkTalk highlighted the announcement of automatic migration of BT retail customers with the BT Infinity 1 product from GEA 55/10 to 80/20.[31] It estimated this migration would apply to [✂] and argued for the migration to be reflected in the charge control which would result in a lower price cap for GEA 40/10 rentals.

Our reasoning and decisions

A10.22 In the remainder of this section we set out our analysis and decisions on service volume forecasts. Our discussion covers the following topics in turn:

- general modelling approach;
- forecasting the number of fixed line UK premises;
- forecasting the number of Openreach lines;
- forecasting individual rental volumes; and
- forecasting connection and ancillary services.

General modelling approach

A10.23 Forecasting volumes of specific services is often difficult as these volumes can be affected by the complex interaction of various factors. We have forecast service volumes using simple methods, e.g. extrapolating current trends, where we consider it appropriate. We also forecast some ancillary service volumes using the historical relationship of that service to its underlying line rental service, and applying this relationship to forecast ancillaries.

A10.24 The outputs of the volumes model are split into two categories:

- Outputs for the top-down model: this includes all WLR, SMPF, MPF, and GEA rentals, connections and ancillary services (e.g. migrations). These forecasts drive the forecast

[29] Openreach's non-confidential response to our March 2017 WLA Consultation – Volume 2, paragraphs 419-430.
[30] Virgin Media's non-confidential response to our March 2017 WLA Consultation, paragraph 59.
[31] TalkTalk Letter to Ofcom, dated 7 November 2017.

costs in the top-down model. Our top-down modelling approach is discussed in more detail in Annexes 11 and 12.

- Outputs for the bottom-up model: this includes all forecast GEA volumes, split into four categories: rentals, PCP provision, connections requiring a visit to the end user, and software changes. These are used in conjunction with the bottom-up model's cost volume drivers to forecast costs. Our bottom-up modelling approach is discussed in more detail in Annex 14.

A10.25 The volumes model does not forecast all the different fibre services that will be provided, or the technology that will be used. Instead it assumes that Openreach will continue to make appropriate decisions regarding the provision of different fibre services such that it can continue to compete with other networks.

A10.26 As set out in Section 2, we are using an anchor technology approach, which means we model all services as if they are provided over a copper network with an FTTC overlay. This approach does not preclude Openreach from providing equivalent or higher speed, or more reliable higher quality services.

A10.27 Our general approach to forecasting specific services, as well as market trends, is to base our forecasts on historical growth rates. Over the longer term, continuous growth (whether negative or positive) at a high rate will often be implausible. Therefore, we have used:

- three-year moving averages – to ensure that our forecasts are also a reasonable reflection of recently observed trends; and
- dampening factors[32] – to slow down the three-year trends to ensure that they are consistent with plausible and stable long-run levels for the key forecast variables.

A10.28 We consider that this approach is appropriate as it allows recent trends to be captured and projected forwards even when the underlying trends are complex and difficult to measure.

A10.29 We consider it appropriate to use a dampening factor even when the historical trend is relatively stable if there is volatility around the observed trend. The use of a moving average without a dampening factor could result in our forecasts replicating any observed volatility. Any resulting volatility in volumes would not be suitable in setting a charge control. For example, a decrease in volumes in one year followed by an equal increase in volumes in the next year could lead to a modelled fall in capital expenditure for the first year followed by an increase in the next. It is unlikely that this would occur in the real world, so we consider the inclusion of dampening factors in our model results in a better approximation of the real world.

A10.30 We have modelled the per annum change in broadband penetration and take-up of fibre services on Openreach's network rather than applying our general approach. We consider

[32] A dampening factor is a divisor applied to the observed historical growth rates in order to calculate a lower forecast growth rate. For example, if MPF rentals grew on average by 14% per annum between 2012/13 and 2015/16, then the forecast growth for 2016/17 will be 14% divided by the dampening factor (e.g. 14% divided by 1.4 giving a forecast 10% growth rate in 2016/17).

it appropriate to explicitly set out what we have assumed for these parameters given their importance. Our broadband take-up assumptions were determined by assessing historical trends and considering how they will continue going forwards which are similar principles as our general approach.

Dampening factors

A10.31 We consider the use of dampening factors to be consistent with modelling stable long-run levels. For example, as the market moves towards saturation we would expect a slowdown in growth, or as the market migrates from legacy services to new services we would expect the fall in legacy service volumes to slow down over time. We generally forecast using a three-year moving average growth rate with a dampening factor of 1.4. This is appropriate when volumes are relatively stable (i.e. limited fluctuations) since it is close to 1 and thus ensures a relatively limited dampening effect. Furthermore, it is consistent with the dampening factor applied in 2014.

A10.32 We have applied alternative dampening factors when we consider historical growth to be particularly different to future growth, e.g. when a service is relatively new and likely to have significantly lower growth in the future compared to its current growth rate.

A10.33 We have not applied a dampening factor where we have considered recent trends to be representative of a long-term trend. For example, where the observed trend has been consistent for the last three years and we have no reason to suggest that demand will change over the charge control period.

A10.34 We note that market conditions could change within the charge control period such that historical trends are not an accurate representation of future trends. We have compared our forecasts with forecasts from other sources (e.g. BT and other telecoms providers that purchase Openreach’s services) to cross-check our assumptions. We have found our forecasts to be reasonable in light of these cross-checks.

Forecasting the number of fixed line UK premises

Number of households

A10.35 The MHCLG publishes forecasts for the number of UK households[33] based upon ONS population projections. We have adjusted its calendar year forecasts into mid-year financial year forecasts to be consistent with the data that BT has provided for actual WLA and WFAEL rentals.[34]

[33] A household is defined, consistent with the 2011 census, as one person living alone or a group of people living at the same address with common housekeeping, i.e. sharing either a living room or at least one meal a day.
[34] Our understanding is that the MHCLG figures are mid-year calendar year values. Therefore, we have converted the MHCLG figures into financial years by adding 0.25 of the growth in that year to the reported calendar year figure.

A10.36 We do not agree with Openreach's submission that we should adjust our household forecasts given observed dwelling growth. We consider it likely that dwelling[35] forecasts would be correlated with household forecasts and in fact observe similar proportional growth rates.[36] We consider that our approach is reasonable and note it is unlikely that the use of dwelling growth would materially impact our forecast unit costs.

A10.37 Our approach ensures consistency within our model as the use of dwelling growth rates would require an upward adjustment to the number of Openreach lines per household.[37] We therefore consider that making such an adjustment would not be appropriate or proportionate.

A10.38 We also consider it appropriate to use the long-term forecasts published by the MHCLG rather than make assumptions of our own. As such, we are of the view, as in the 2014 FAMR statement,[38] that adjusting our household forecasts would not improve the accuracy of our forecast of Openreach lines.

A10.39 We forecast that UK households will increase from 27.8 million in 2016/17 to 28.9 million in 2020/21. We expect that this increase in households will flow through to an increase in the number of Openreach lines, although not on a 1-to-1 basis.

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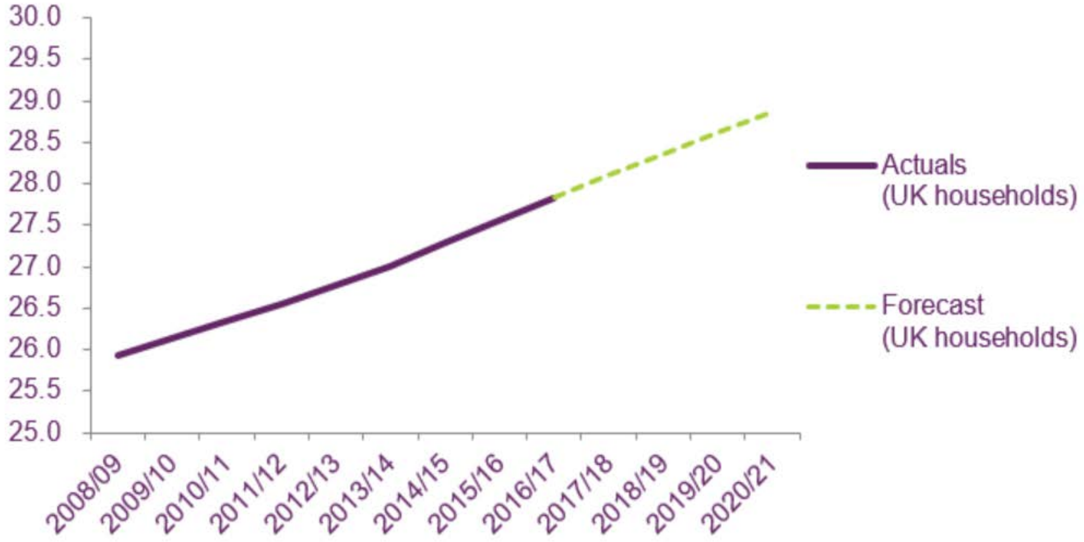
[35] The 2011 census defines a dwelling as a single self-contained household space (an unshared dwelling) or two or more household spaces at the same address that are not self-contained, but combine to form a shared dwelling that is self-contained. We note that MHCLG does not forecast dwellings.
[36] We note that recent dwellings growth (as provided in Openreach's response) suggests a flattening to around 0.6% increase per annum. This is compared to the average per annum household growth in the volumes model of around 0.9% over the charge control period.
[37] In the model, prior to adjusting for the impact from future competitive network build, we use the observed change in number of Openreach lines per household to determine forecast Openreach lines. If we were to adjust the household growth forecasts based on observed dwelling growth, then it would be appropriate to also reflect this change in the observed number of Openreach lines per household. We note that the number of Openreach lines per household is inversely related to the number of households, thus if the number of modelled households decreases then the number of Openreach lines per household would increase.
[38] Ofcom, 2014 FAMR Statement, paragraphs A24.90-96.

Figure A10.2: Forecast of UK residential households (m)



Source: MHCLG[39] (including Ofcom adjustment to create mid-year values).

Mobile-only households

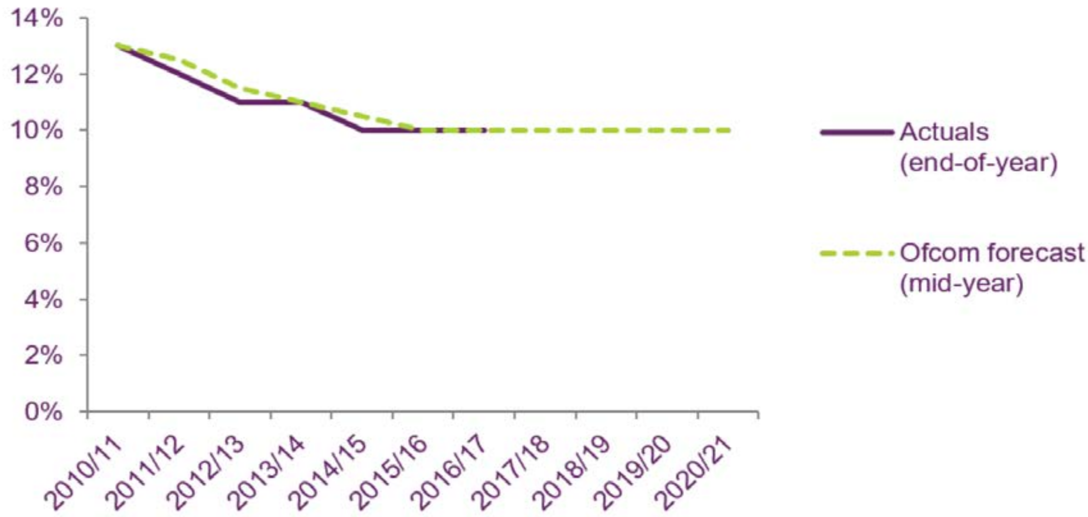
A10.40 We have removed households with no fixed line as these households do not contribute to Openreach's service volumes. We refer to these as 'mobile-only households' and have forecast the proportion of UK households that fall in this category based on Ofcom's Technology Tracker survey.[40] We note that these survey results have a margin of error in the region of plus or minus two percentage points. However, we consider this to be the best available source for determining mobile-only UK households.

A10.41 The proportion of UK households that are mobile-only has steadily declined since 2010/11 but appears to have flattened at 10% over the last few years. Therefore, we consider it likely that this proportion will remain at around 10% over the charge control period. We note that TalkTalk considered a decline to be appropriate whilst Openreach suggested an increase. Based on the recent evidence and stakeholder responses, we consider it appropriate to assume that the proportion of households that are mobile-only will remain stable at 10%.

[39] http://www.communities.gov.uk/housing/housingresearch/housingstatistics/housingstatisticsby/householdestimates/livetables-households.

[40] Ofcom, *Technology* Quarter 1 for 2009-2014 and Half 1 for 2015-2017 *Tracker,* we use data from field work conducted in January and February of each year. https://data.gov.uk/dataset/technology-tracker-wave-3-2012.

Figure A10.3: Forecast of the proportion of UK households that are mobile-only



Source: Ofcom Technology Tracker (survey fieldwork undertaken January and February each year).

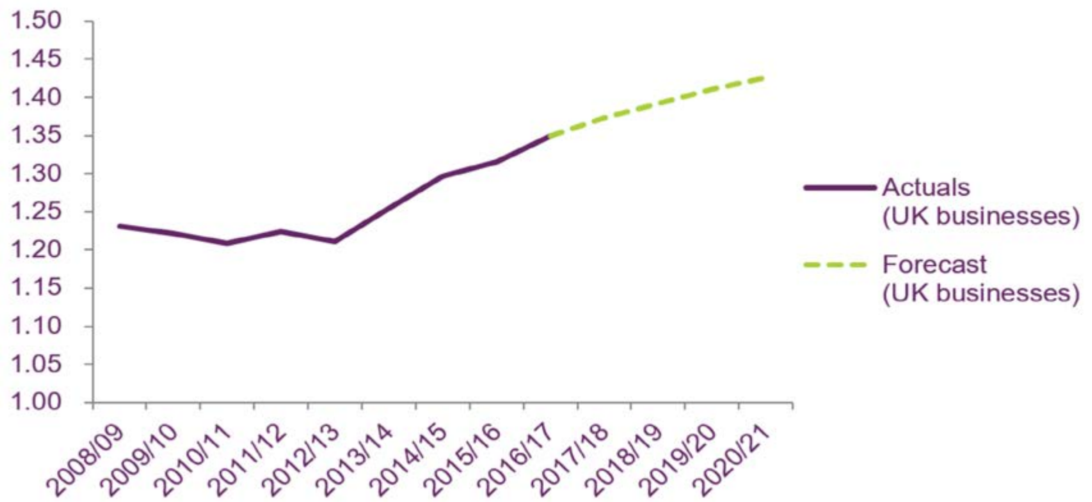
Business sites

A10.42 For our business lines forecast we have taken into account the forecast growth of SMEs[41] as larger businesses are more likely to obtain connectivity using a leased line service rather than a WLA or WFAEL service. We have used historical data on the number of registered sites for SMEs published by BEIS[42] to inform the starting point for our forecasts.

A10.43 The number of business sites significantly increased from 2012/13 to 2016/17 and we note that the number of SMEs increased significantly in 2016/17 even with relatively slow GDP growth in that year. Therefore, we do not consider it appropriate to apply a greater dampening factor to reflect any future economic uncertainty.[43] We consider it appropriate to use our default approach of a three-year moving average growth rate with a dampening factor of 1.4.

[41] The most frequently used upper limit for SMEs is 250 employees so we have calculated the number of firms with 1 to 249 employees. We note that this is consistent with our approach in the 2014 FAMR Statement and that a similar figure is obtained if we only looked at firms with 1 to 49 employees.
[42] BEIS, 30 November 2017, Business population estimates 2017 https://www.gov.uk/government/statistics/business-population-estimates-2017.
[43] We have assessed the impact of adjusting business site growth to reflect the OBR's forecasts for GDP, which we consider to be an appropriate proxy for the impact that future economic uncertainty might have on line growth. We have found that the impact on our charge controls is not significant, i.e. less than a 0.5% impact on rental prices.

Figure A10.4 Forecast of UK Business sites (m)



Source: Private sector businesses with 1 to 249 employees; Ofcom mid-financial year adjustment to data provided by BEIS.[44]

Forecasting the number of Openreach lines

Openreach lines per fixed line household/business

A10.44 We have estimated the number of Openreach residential and business lines by applying the industry proportion of residential and business fixed lines to actual total Openreach lines. We then use this estimated split to calculate the number of Openreach residential lines per UK household and Openreach business line per SME business site.

A10.45 We note that this approach implicitly models the impact on Openreach lines due to existing competitor networks, e.g. Virgin Media's non-Project Lightning footprint. Any increase in competition from existing competitive networks will be captured in the Openreach historic volumes and applied to our forecasts. We have collected Openreach's actual line volumes for 2016/17 and believe this implicitly captures the current level of competition between network providers. The purpose of our competitor network adjustment (discussed further below) is to capture the incremental change to network competition given additional roll-out of competitor networks.

A10.46 We find that the number of Openreach lines per fixed line household has remained relatively stable at around 0.87 since 2011/12.[45] Therefore, we have used a three-year moving average growth rate with no dampening factor to continue this trend.

A10.47 We also found that the number of Openreach lines per business site has continually declined between 2011/12 and 2016/17 from 3.41 to 2.43. Business lines appear to be in long term decline, even with recent growth in the number of business sites. We consider it

[44] https://www.gov.uk/government/statistics/business-population-estimates-2017.

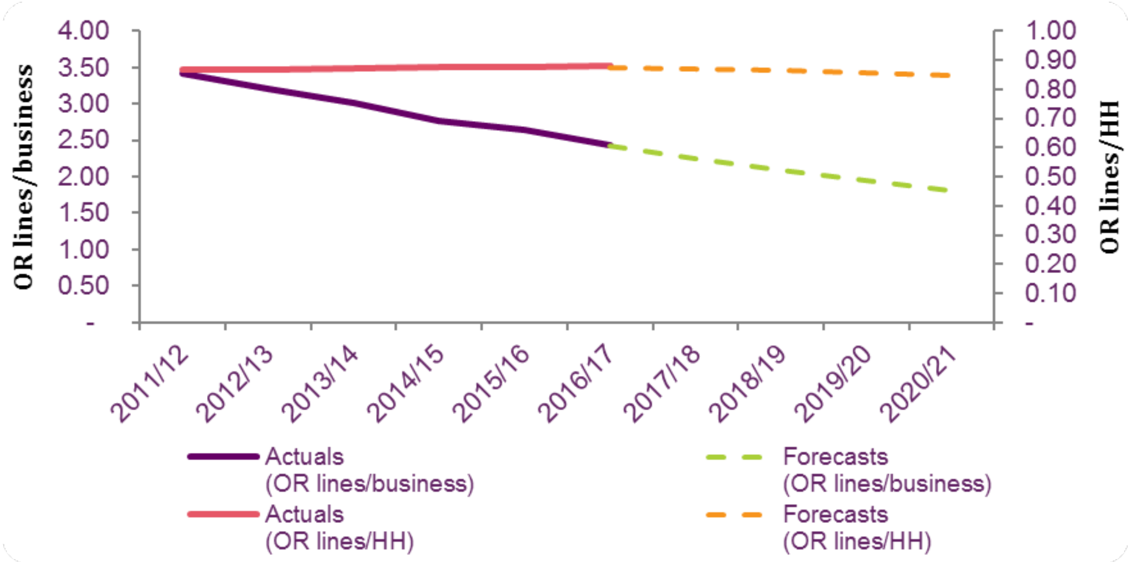
[45] This is excluding any impact from competitive networks, which we capture within our competitive network adjustment.

likely that this trend is due to the declining use of ISDN and increasing take-up of VoIP, as well as consolidation of multiple lines into a single line per business site.

A10.48 We agree with Openreach that it is likely that this significant decline will persist over the charge control period. We do not consider it appropriate to apply a dampening factor of 1.4. Instead, we have used a dampening factor of 1.1, which is consistent with the actuals. Therefore, we have used a three-year moving average growth with a dampening factor of 1.1.

A10.49 Our forecasts are shown in Figure A10.5 below with the left-hand axis showing Openreach business lines per business site and the right-hand axis showing Openreach residential lines per household.

Figure A10.5: Forecast of Openreach (OR) lines per household (HH) and per business site



Source: Ofcom forecast based on Openreach actuals and applied to BEIS and MHCLG forecasts with Ofcom adjustments (e.g. for competitive network impact).

Competitor network impact

A10.50 In the March consultation, we made an adjustment of around 0.3 million lines per annum to account for the impact of competitor network build excluding the use of PIA. We primarily based this figure on Virgin Media's Project Lightning rollout.[46] In light of market developments and stakeholder responses, we have expanded this competitor network adjustment to specifically include network providers such as Virgin Media, Hyperoptic, Gigaclear, [✂], and CityFibre/Vodafone.

A10.51 We have based our competitor network adjustment on volumes data obtained using our statutory information gathering powers. We have used actuals (from 2011/12 to

[46] Project Lightning is Virgin Media's recent large-scale investment programme.

2017/18)[47] and forecasts for premises passed[48] and the number of lines with an active subscription from the telecoms providers listed above from 2018/19 to 2020/21.

A10.52 We evaluated each forecast based on our assessment of likely network build, penetration rates and the actuals to date. We noted differences in the speed of rollout, i.e. the proportional increase in premises passed, between competitor networks. However, we found that these differences corresponded with differences in penetration rates.[49] For the most part, we considered the forecasts provided by network providers to be reasonable. We anticipate that our modified PIA remedy will encourage additional competitor network build which we consider is reflected within our competitor network forecast impact.

A10.53 However, we have used our judgement to make appropriate adjustments to [✂]. We consider it reasonable to expect relatively limited take-up of new services or services which have not been tested at a significant scale. For example, we consider it reasonable to model significant take-up of FWA over the charge control period but would not expect take-up of this service to exceed alternative technologies such as cable.

A10.54 Based on information supplied by [✂], we consider it reasonable to expect coverage of [✂] households by 2020/21 rather than the provided forecast of [✂] households. We also consider it appropriate to assume a penetration rate of [✂]% since this consistent with [✂]. Therefore, we have forecast the impact of [✂] lines over the charge control period.

A10.55 Overall, these adjustments result in an average competitor network impact of [✂] million lines per annum during the charge control period. We note that in the model we have not applied this average impact. Instead, we have made an adjustment for each forecast year based on the rollout and take-up profiles provided by the telecoms providers that are likely to deploy new networks.

Table A10.6: Forecast cumulative impact of competitor network build including any use of PIA (m lines)

	2017/18	2018/19	2019/20	2020/21
Cumulative impact of competitor network build	[✂]	[✂]	[✂]	[✂]

Forecasting individual rental volumes

Broadband and fibre penetration

[47] To the extent providers could supply actuals for 2017/18.

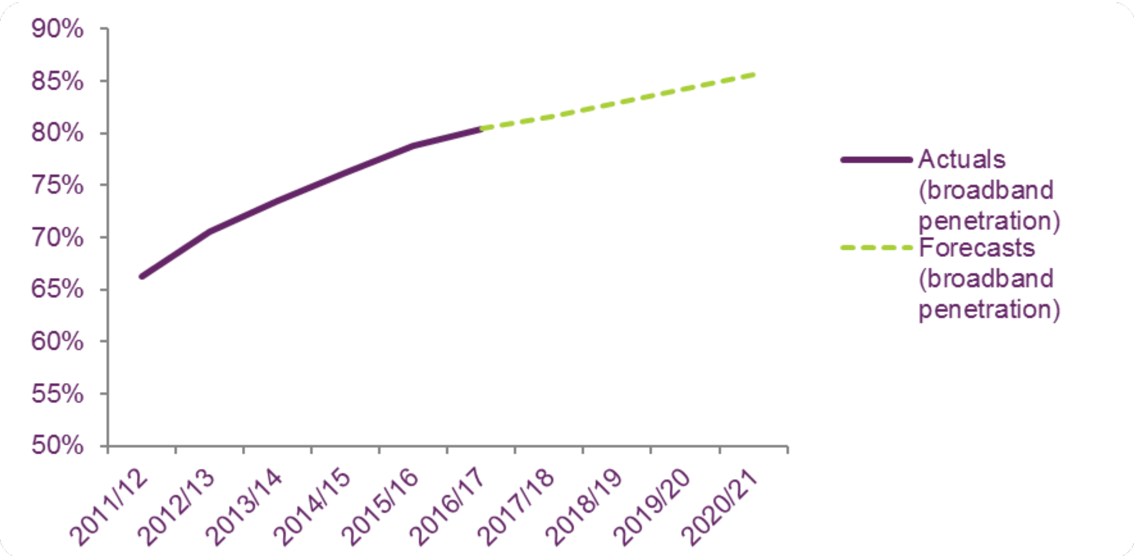
[48] Which we defined as homes or businesses (excluding those obtaining a leased line equivalent service) which could be connected to the provider’s network using limited incremental capital expenditure.

[49] We find that where a telecoms provider responded with a relatively high speed of rollout, there was a corresponding lower penetration rate. [✂].

A10.56 We refer to the take-up of broadband on Openreach's network as "broadband penetration" which includes both copper and fibre services. We refer to the relative take-up of fibre (including both FTTC and FTTP) services when compared to overall broadband take-up as "fibre penetration".

A10.57 We have observed that the take-up of broadband for Openreach lines has increased steadily since 2011/12, but this trend has recently started to flatten. Based on the more recent growth in broadband penetration for Openreach lines, we have assumed a per annum growth rate of 1.5 percentage points. We consider it likely that broadband penetration will continue to grow at this lower rate and will reach 86% by 2020/21. This is illustrated in Figure A10.7 below.

Figure A10.7: Forecast broadband penetration of Openreach lines



Source: Ofcom forecast based upon Openreach actuals[50]

A10.58 Fibre penetration has increased steadily since 2011/12. However, in light of the available evidence, including representations from Virgin Media and Openreach, we consider it appropriate to forecast lower fibre penetration in 2020/21 than we proposed in the March consultation.

A10.59 We have assumed that fibre penetration will increase on average by 7 percentage points per annum during this charge control period, excluding the competitor network impact set out above.[51] Furthermore, in light of 2016/17 actuals and forecasts for fibre services supplied by telecoms providers, we consider it appropriate to not apply an average growth rate. Instead we apply a growth rate in 2017/18 that is greater than 2016/17, with a declining growth rate for each subsequent year. Figure A10.8 below shows our forecasts for fibre penetration over the charge control period, which reach 61% by 2020/21.

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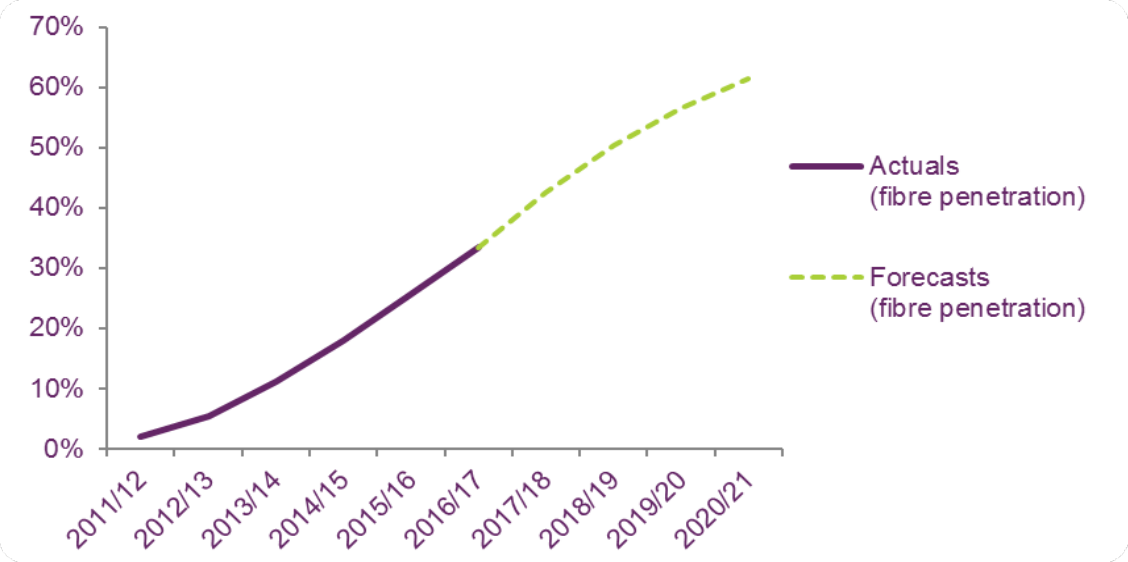
[50] Openreach's response dated 13 September 2017 to question 2f of the 34th s.135 notice and Openreach's response dated 25 January 2018 to the 44th s.135 notice.

[51] Given that we apply the impact of network competition on broadband lines only, this results in the final broadband penetration figures to be slightly lower than if we assumed no impact from network competition.

Figure A10.8: Forecast proportion of Openreach broadband lines that are fibre services



Source: Ofcom forecast based upon Openreach actuals[52]

A10.60 [✂].

Additional considerations

A10.61 In addition to the forecasting parameters set out above, we also consider the following key parameters will significantly influence demand for copper services:

- the potential for further LLU rollout; and
- internal and external split of Openreach broadband volumes,[53] where an internal copper line is one that a downstream BT division purchases from Openreach, and an external copper line is one that is purchased by a non-BT telecoms provider.

A10.62 We consider it likely that LLU rollout will continue to be very limited in this charge control period, as supported by the flattening in growth of MPF rentals over the last few years. This is consistent with the analysis found in the 2017 WBA consultation.[54]

A10.63 In relation to the internal and external split of lines, we have assumed a one percentage point decline per annum in the proportion of copper broadband lines that are internal over the charge control period. This is consistent with the most recent growth in actual external copper broadband lines.

A10.64 The volumes model does not forecast Single Order GEA (SOGEA) but instead assumes the continued use of WLR with GEA or MPF with GEA.[55] Although we might expect SOGEA volumes over the charge control period, we do not consider it necessary to forecast these

[52] Openreach response dated 13 September 2017 to question 2f of the 34th s.135 notice and Openreach response dated 25 January 2018 to a further question regarding the 44th s.135 notice.
[53] We note that the forecast internal and external split of WLR lines that are not purchased with SMPF or GEA does not have an impact on our charge controls.
[54] 2017 WBA Consultation, https://www.ofcom.org.uk/__data/assets/pdf_file/0013/103180/wba-consultation.pdf.
[55] We discuss our approach to price regulating SOGEA in Volume 1, Section 9.

volumes given our anchor technology approach (where the anchor technologies are copper-only and GEA-FTTC).

A10.65 These general forecasts provide the underlying market trends and impact on Openreach rentals. We now discuss the next stage of our analysis where we set out our assumptions for deriving forecasts for WLA and WFAEL connection and ancillary services.

A10.66 We now set out the assumptions used for forecasting specific copper and fibre rentals. We have requested actual copper service volumes (from 2012/13 to 2016/17) and forecasts (from 2017/18 to 2020/21) from BT Group and other telecoms providers using our statutory information gathering powers. We have used this data to inform our forecasts for Openreach copper services. Where possible, we have used publicly available service volumes from the RFS.

SMPF rentals

A10.67 SMPF rentals have declined over recent years and we forecast they will continue to do so. This is primarily driven by migration from SMPF to MPF[56] and take-up of fibre services, given that SMPF is not required to provide superfast broadband, and the proportion of broadband lines that are superfast is growing.

A10.68 We have forecast internal SMPF rentals based on the forecast growth rate in copper broadband lines and the forecast change in the internal share of copper broadband lines. Our forecasts of external SMPF rentals are based on a three-year average growth rate with a dampening factor of 1.4. This results in the forecast volume of external SMPF rentals flattening over the charge control period.[57]

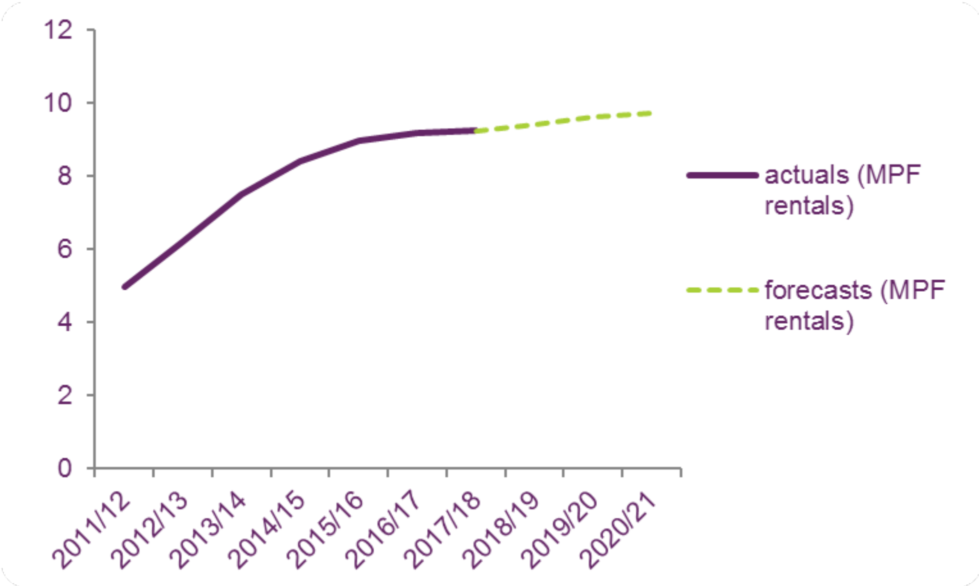
A10.69 We have not applied any further adjustments to our forecasts for SMPF rentals, which are broadly consistent with the actuals and forecasts provided by other telecoms providers.

MPF rentals

A10.70 MPF rental volumes have increased over recent years and we forecast they will continue to do so. This is driven by the continuing increase in broadband penetration and migration from SMPF to MPF.

[56] This includes both the migration of external SMPF volumes to external MPF as well as migration of internal SMPF to external MPF within this charge control period.
[57] We note that external SMPF rentals continue to decline after MPF Bulk Migrations are modelled to be zero. We consider this to be consistent with a movement to fibre services and churn (e.g. movement from external SMPF to internal SMPF and upgrading from SMPF to GEA).

Figure A10.9: Forecast MPF rentals (m)



Source: Ofcom forecast based upon Openreach actuals[58]

A10.71 We note that the majority of MPF rentals are purchased externally. Therefore, we have forecast MPF rentals based on external fibre and copper broadband forecasts but excluding our external WLR with GEA forecasts and external SMPF forecasts. Our forecasts for WLR with GEA are based on information provided by Sky and Vodafone. We have extrapolated Sky's forecasts since it did not directly provide forecasts for WLR with GEA.

A10.72 Our forecasts of MPF rentals are in between the forecasts provided by Openreach and by other telecoms providers. Our forecasts are broadly reflective of the expectations of Openreach, Sky, and TalkTalk throughout this period.

A10.73 We do not separately forecast different MPF rental service levels in the volumes model. We take into account the different service level mixes within the top-down model as part of our QoS adjustments (see Annex 13).

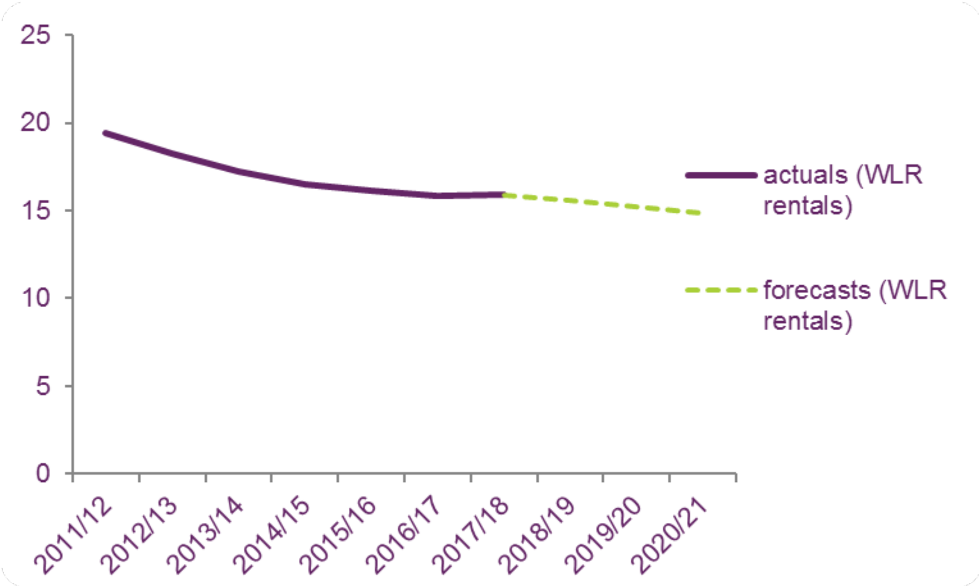
WLR rentals

A10.74 Forecast WLR rentals (excluding external WLR with GEA volumes which we forecast separately) are based on the difference in the forecast total Openreach lines and forecast MPF lines.

A10.75 We note that BT forecasts a significantly greater decline in WLR rental volumes compared to our forecasts, even when accounting for differences due to its forecasts of SOGEA. This difference is likely to be primarily driven by different forecasts for the competitor network impacts. As set out above, we consider our forecast for the competitor network impact to be reasonable and are therefore satisfied with the decline in WLR rentals within our forecasts.

[58] Openreach response dated 13 September 2017 to question 2f of the 34th s135 notice

Figure A10.10: Forecast WLR rentals (m)



Source: Ofcom forecast based upon Openreach actuals[59]

A10.76 WLR rentals include both Analogue Core WLR rentals and Analogue Premium WLR Rentals (as defined in the RFS). Analogue Core WLR Rentals are voice line rentals primarily used by residential customers, whilst Analogue Premium WLR Rentals are voice line rentals primarily used by business customers.

A10.77 From 2012/13 to 2016/17, there has been a steady move from premium to core WLR rentals and we expect this trend to continue given the consistent decline observed in the historic volumes. Therefore, we consider it appropriate to use a three-year moving average with no dampening factor in forecasting the volumes associated with WLR core and premium rentals.

Fibre rentals

A10.78 We forecast fibre service volumes at a national level (as well as at the level of BT's commercial rollout) for two reasons:

- We have more information on national volumes than at the level of commercial rollout. We consider it appropriate to use the additional information that we have on national volumes to better inform our commercial volume estimates.
- We forecast and allocate common costs at a national level. This is to ensure that the appropriate amount of common costs are allocated to fibre in light of our equi-proportional mark-up (EPMU) approach (as discussed in Annex 11).

A10.79 National fibre service volumes (i.e. including volumes in state funded areas) have been rapidly increasing over recent years as demand rises for fibre services. Our forecasts for

[59] Openreach response dated 13 September 2017 to question 2f of the 34th s135 notice

national fibre volumes are driven by a combination of Openreach line forecasts, broadband penetration, and fibre penetration.

A10.80 We requested actuals (from 2012/13 to 2016/17) and forecasts (from 2017/18 to 2020/21) for fibre service volumes from BT and other telecoms providers using our statutory information gathering powers. We have used this data to inform our forecasts for Openreach fibre services.

A10.81 Before forecasting the volumes of specific fibre services, we considered the following key factors:

- internal and external split of fibre services;
- GEA split by bandwidth; and
- the forecast split of fibre volumes between commercial and subsidised fibre areas.

Internal and External split

A10.82 An internal fibre line is one that a downstream BT division (including EE and Plusnet) purchases from Openreach, whereas an external fibre line is one that is purchased by a non-BT telecoms provider.

A10.83 We forecast a decline in the proportion of fibre services that are internal. We expect Sky, TalkTalk, and Vodafone are likely to focus on obtaining fibre customers[60] thus catching up to BT's use of fibre services. We note that the proportion of internal fibre lines fell from around [✂] (70-75)% in 2015/16 to around [✂] (66-71)% in 2016/17.

A10.84 Therefore, we have assumed a 4% per annum decline in the proportion of Openreach fibre lines that are internal over this charge control period. This results in roughly an equal split of internally and externally purchased fibre lines by 2020/21.

GEA bandwidth split

A10.85 Having forecast Openreach fibre rentals, we consider it appropriate to split these rentals by bandwidth given our decision on allocating common costs across different GEA-FTTC bandwidths. Therefore, our discussion below will specifically refer to GEA FTTC services as these are the services against which we benchmark our bandwidth gradient.

A10.86 We split our forecasts for fibre rentals into the various FTTC bandwidths that Openreach currently provides (i.e. 40/2, 40/10, 55/10, and 80/20). As set out in Volume 1, we have decided to set a charge control on GEA 40/10 rentals.

A10.87 As we are imposing a charge control on the GEA 40/10 service, we need to determine the appropriate allocation of GEA-FTTC common costs to this service. As set out in Section 2 and Annex 11, we consider it appropriate to apply a bandwidth gradient to determine the appropriate allocation to GEA-FTTC 40/10 services. Therefore, we need to forecast the service volumes for each of the available GEA-FTTC bandwidths. Our forecasts are set out below:

[60] This could either be by other telecoms providers winning superfast broadband customers that are currently with BT or by upgrading their existing standard broadband customers to superfast.

Figure A10.11: Forecasts for national GEA (internal and external volumes), broken down by bandwidth (m) [✂]

Source: Ofcom forecasts

A10.88 We expect that the GEA 80/20 and 40/10 bandwidths will have the highest volume increases over the charge control period. We consider this reasonable as we expect the 80/20 bandwidth to be BT's primary GEA service, and the 40/10 service to be primary service for other telecoms providers. We set out below our reasoning behind these bandwidth splits for our national GEA forecasts.

External volumes

A10.89 The GEA 18/2 service was withdrawn by BT in 2016/17. Therefore, we expect fibre volumes at these speeds to fall over time. As a modelling simplification we consider it appropriate to assume zero volumes of 18/2 across all forecast years. For GEA 40/2 volumes, we have based our forecasts on those supplied by telecoms providers given the significant migration away from 40/2 in 2017/18.

A10.90 There is limited external use of GEA 55/10, so we have based our forecasts on 2016/17 actuals held constant. For GEA 80/20, we have used the standard forecasting approach of a three-year moving average with a default dampening factor of 1.4 given the gradual increase in the historic actuals.

A10.91 We have then forecast the proportion of GEA 40/10 volumes to be the remaining GEA lines after we have calculated the volumes of other bandwidth services. This ensures that the summation of all bandwidth rentals equals the total forecast volume. It also means that we forecast a gradual movement from GEA 40/10 to 80/20 based on historical trends.

Internal volumes

A10.92 For GEA 18/2 and GEA 40/2 volumes, we have used the same approach in forecasting internal volumes as we have used in forecasting external volumes. For GEA 40/10 volumes, we have used the standard forecasting approach of a three-year moving average with a default dampening factor of 1.4.

A10.93 For GEA 55/10 volumes, we have used 2017/18 volumes provided by Openreach to forecast 2017/18 and 2018/19 volumes. For the subsequent years, we note that Openreach forecasts have not been signed off by senior governance so we have put less weight on these forecasts and used a two-year moving average with the default dampening factor of 1.4.

A10.94 We have then forecast the proportion of GEA 80/20 volumes to be the remaining GEA lines after we have calculated the volumes of other bandwidth services. We have used this approach in light of TalkTalk's response and forecasts from Openreach which suggest significant migration away from 55/10 to 80/20.

Commercial split

A10.95 We model volumes on a national and commercial level. We define commercial as the areas of the UK in which Openreach's fibre deployment has not been subsidised. For the purposes of providing volumes for the bottom-up model, we are interested in Openreach's commercial footprint.

A10.96 BT has provided the last three years of actuals for the proportion of fibre rentals, connections, and ceases that are in commercial areas.[61] We have assessed these splits and consider them to be reasonable. Therefore, we have used these figures to calculate the volume of services provided in the commercial area for 2014/15 to 2016/17.

A10.97 We calculate a "commercial conversion factor" which is the proportion of total GEA service volumes that we estimate to be commercial. This is then used to forecast commercial volumes for all years. We have separately estimated a commercial conversion factor for GEA rentals[62] and GEA ceases. We then calculate commercial GEA connections as a remainder based on our commercial GEA rentals and commercial GEA ceases.

A10.98 In our volumes model, we have provided historical volumes prior to 2014/15 for the bottom-up NGA model. We have estimated the commercial split for 2011/12 to 2013/14 as this level of detail was not available from BT.[63] We note that fibre volumes prior to 2011/12 would likely be almost entirely commercial.

A10.99 However, the historical commercial split has a limited impact on unit costs given that we have used a CCA approach for cost recovery within the bottom-up model. We consider the commercial split of capital expenditure for historical years to be an appropriate proxy for the historical split of fibre volumes.[64]

A10.100 The key aspect of forecasting the rental commercial split is estimating the steady state figure (i.e. the proportion of total GEA rentals that are commercial at the end of the model period). We continue to consider that the steady state figure of 69% is an appropriate estimate. Therefore, we have forecast a reduction of one percentage point per annum in the commercial conversion factor up to 2020/21, which is consistent with a long run steady state of 69%.

Figure A10.12: Commercial conversion factor for fibre rentals from 2011/12 to 2020/21 [✂]

Source: Ofcom forecasts

Forecasting connection and ancillary services

MPF ancillaries

MPF New Provides

A10.101 MPF New Provides are primarily purchased when a customer moves into a household that did not previously have a connection to BT's network. These can be either new households or consumers who have switched from a competitive network.

[61] Openreach response dated 13 September 2017 to Q6 of 34th s.135 notice.
[62] We have applied the GEA rental conversion factor to GEA bandwidth changes and GEA migrations.
[63] Openreach's follow-up response dated 8 September 2016 to question 5 of the 6th s.135 notice.
[64] For example, if we found that 90% of capital expenditure for fibre services in 2012/13 was for commercial areas then we would assume that 90% of fibre rentals were in commercial areas.

A10.102 There has been an increase in the usage of total MPF New Provides over the previous three years, triggered by the take-up of MPF. We expect the number of MPF New Provides to slightly increase over the charge control period, in line with increases in MPF rentals and greater churn between competitive networks.

A10.103 On this basis, we have forecast that MPF New Provides will increase in line with MPF rentals, using the 2016/17 ratio of new provides to rentals which we apply across all modelled years.[65]

MPF Single Migrations

A10.104 MPF Single Migrations are caused by churn to MPF from either WLR or a different telecoms provider using MPF. The increase in broadband penetration and LLU rollout are possible volume drivers for this service.

A10.105 Therefore, we consider that MPF Single Migrations will increase in line with total Openreach broadband lines.[66] On this basis, we have used the historical ratio of MPF Single Migrations to total Openreach broadband lines to calculate our forecast. This ratio declined from 2012/13 but appears to have stabilised in 2016/17. We consider that this flattening trend is due to limited LLU rollout over the last few years.

A10.106 We expect limited LLU rollout over the charge control period so we consider the use of the 2016/17 ratio to be appropriate when forecasting. We therefore apply the 2016/17 ratio to our forecast rentals (which are driven by broadband penetration).

MPF Bulk Migrations

A10.107 MPF Bulk Migrations are driven by telecoms providers moving large quantities of customers from WLR plus SMPF to MPF. This primarily occurs in exchanges where a telecoms provider has added MPF capability at an exchange (i.e. unbundled the exchange). We consider it appropriate to forecast low volumes for this service due to limited expected LLU rollout over the charge control period.

A10.108 We have forecast external MPF Bulk Migrations based on the reduction in external SMPF lines less those customers that churned to other providers during that year. However, when this estimate results in negative volumes, we have set MPF Bulk Migrations to equal Openreach's forecasts (which in our model occurs in 2018/19). We have assumed zero internal MPF Bulk Migrations, consistent with the observed actuals.

Co-Mingling New Provides

A10.109 Demand for Co-Mingling New Provides is caused by unbundling exchanges and capacity expansion. The volumes of co-mingling new provide services are driven by parameters which are difficult to predict, such as the spare capacity telecoms providers have in their

[65] We consider it appropriate to use the most recent actual ratio given that any decline in the ratio due to limited LLU rollout is likely to have stabilised by 2016/17.

[66] Total Openreach broadband lines is taken as total MPF lines plus total SMPF lines plus internal GEA FTTC and total FTTP lines.

already installed racks and in each BT exchange, and market share fluctuations in different geographies.

A10.110 The number of room builds in the forecast period is expected to decrease as the level of new unbundled exchanges decreases. However, we note that there are also upgrade services within the Co-Mingling New Provides basket.[67] Therefore, it is not clear whether overall volumes will necessarily fall for this basket of services.

A10.111 We have used a three-year average growth rate with a dampening factor of 1.4 to forecast Co-Mingling New Provides. As set out in Annex 12, we have adjusted the top-down model to hold unit costs flat for the co-mingling set up component (which is exclusively used by co-mingling new provide services). Therefore, our forecasts for co-mingling new provides do not have a significant impact on our charge controls.

Co-Mingling Rentals

A10.112 Co-Mingling rentals are a collection of services relating to the running costs of building space used for unbundled lines used by telecoms providers other than BT. This building space is used for both MPF and SMPF equipment, depending on the exchange and the telecoms provider in question. Service volumes for Co-Mingling rentals can increase due to further unbundling and capacity expansion, and can decrease due to decommissioning of old or under-utilised equipment and consolidation of MPF and SMPF providers.

A10.113 Between 2011/12 and 2013/14, the volume of Co-Mingling rentals increased which was likely driven by the increase in broadband penetration and unbundling of exchanges. Going forward, we expect broadband penetration and MPF rental volumes to continue to increase which will result in service volume growth for Co-Mingling rentals.

A10.114 We forecast these services to trend with external LLU volumes using the most recent (in this case 2013/14) ratio of Co-Mingling rentals to external LLU rentals, and apply this ratio to the forecast external LLU rentals.

Hard Ceases

A10.115 Hard Ceases include volumes for both MPF and SMPF. These services are primarily used by telecoms providers where an MPF or SMPF service has been terminated and the jumpers are physically removed. We expect hard ceases to change in line with SMPF and MPF rentals.

A10.116 The ratio of Hard Ceases to LLU rentals has fluctuated around 9% over the last three years. We note that the 2016/17 ratio for external Hard Ceases was significantly lower than the 2014/15 or 2015/16 ratio. We do not consider it appropriate to forecast Hard Ceases by applying a ratio found in any specific year as the use of these services can vary significantly each year. Therefore, we no longer consider it appropriate to use a two-year average, as we proposed in our March consultation, since this applies too much weight to the 2016/17 actuals.

[67] For example, purchasing of HDF sub racks.

A10.117 In light of these fluctuating ratios, we have decided to use an average of the last three years of ratios to determine the forecast ratio for both internal and external Hard Ceases.

Tie Cables

A10.118 Tie Cables connect from the Main Distribution Frame (MDF) to a telecoms providers' network equipment within the BT exchange. Each customer supplied by an LLU operator will be connected to that telecoms provider via a pair of copper wires on the tie cable. As such, we expect these services to be primarily driven by LLU rental volumes.

A10.119 We forecast these services based on the most recent actual ratio (in this case, 2013/14)[68] of Tie Cables to LLU rentals and apply this to the forecast LLU rentals. This forecasting method is used both for Tie Cables sold internally and externally.

Other copper connection and ancillary services

A10.120 Although we have decided not to set a charge control for any of the following services, it is necessary to forecast their volumes to capture the appropriate economies of scale and scope for Openreach's network components (some of which are used by both charge controlled and non-charge controlled services). However, we note that our forecasting assumptions for these services have a limited impact on our charge controls.

WLR connection and ancillary services

A10.121 WLR connection and ancillary services include the following:

- Connections: used to connect households such that a WLR rental can be purchased.
- Transfers: used when end customers change their WLR provider.
- Conversions: used to migrate from MPF to WLR purchased without SMPF (a migration from MPF to WLR with SMPF is likely to be a simultaneous conversion, which we forecast separately).

A10.122 We have forecast the internal and external split of these services based on their 2016/17 ratios. In our March consultation, we proposed to use either the average ratio for the last one, two or three years of historical ratios dependent on the degree of fluctuation observed in the actuals. However, EE's volumes were reclassified from external to internal in BT's RFS in 2016/17. Therefore, we consider the use of ratios prior to 2016/17 to no longer be appropriate.

SMPF connection and ancillary services

A10.123 SMPF connection and ancillary services include the following:

- Connections: used to connect households such that an SMPF rental can be purchased.
- Transfers: driven by churn between SMPF providers or when consolidating legacy copper broadband services to SMPF (e.g. with SMPF Bulk Migrations).
- Conversions: used to migrate to SMPF from MPF.

[68] As with co-mingling rental volumes, BT was unable to provide consistent volumes after 2013/14. Therefore, we have used the 2013/14 ratio when forecasting.

A10.124 As proposed in our March consultation, we expect SMPF connections, transfers and conversions to be driven by changes in SMPF rentals. Therefore, we have generally used historical ratios and applied these to our SMPF rentals estimates to forecast SMPF connections and ancillaries. For SMPF Bulk Migrations we assume a year on year reduction of 80%.[69]

Fibre connection and ancillary services

Fibre connections

A10.125 GEA-FTTC connections are used when new GEA lines are installed. These services are split into PCP-only install (i.e. cabinet only installation), managed engineer install (this includes installing equipment at the premises of the end customer), and start of stopped line.

A10.126 We forecast the national level of GEA-FTTC connections and the commercial only GEA-FTTC Connections in a similar way. We forecast GEA-FTTC connections based on the change in end-of-year GEA rentals, for internal and external, plus the internal and external GEA ceases in that year.[70]

A10.127 We have also forecast the proportion of GEA-FTTC connections that require an Openreach engineer visiting the end user's premises. We observe a trend in the actuals towards greater use of PCP-only installations which we expect to continue over the charge control period. Therefore, we consider it appropriate to use a three-year moving average growth rate with a dampening factor of 1.4.

Fibre migrations

A10.128 GEA CP to CP Migration is used when the telecoms provider that purchases the GEA service for a given household changes. Since the service was initially offered in 2013/14, GEA CP to CP migration has increased significantly year on year driven by the increase in GEA rentals and retail competition. We expect that the number of GEA CP to CP Migrations over the forecast period will continue to increase with increases in fibre penetration.

A10.129 There were few CP to CP migrations in 2013/14 yet significant volumes in 2016/17. We consider that only the more recent actuals (i.e. 2014/15 to 2016/17) should be used for our forecasts since otherwise we would forecast unreasonably low volumes. On the other hand, the last three years of actuals show a substantial proportional increase and we do not consider it likely that a similar proportional increase will continue over the charge control period.

A10.130 We expect the recent growth to slow and align with fibre rental growth, and we have therefore applied a substantially higher dampening factor of 3. We note that the forecast

[69] In 2019/20 and 2020/21 our forecasts are consistent with Openreach.

[70] We have not used the forecast GEA Migrations to determine the movement from internal to external GEA-FTTC Connections. This is because we forecast the external and internal split for GEA Migrations to be roughly 50%, and thus the net migrations are forecast to be close to zero.

ratio of migrations to rentals for GEA increases, which we consider to be consistent with the expectation that churn between telecoms providers using GEA will increase.[71]

Other fibre ancillary services

A10.131 GEA Other are an aggregation within the volumes model of the following services:

- Bandwidth Changes; and
- Ceases.

A10.132 However, instead of forecasting the ratio of GEA Other to GEA rentals, we directly forecast volumes for GEA Ceases and Bandwidth Changes.

A10.133 As with GEA Migrations, we consider it appropriate to apply a substantially higher dampening factor than 1.4. This is because we consider it unlikely that future growth will be anywhere near as substantial as that observed over the last three years. Therefore, we follow a similar approach to forecasting GEA Other as we do for GEA CP to CP Migrations, i.e. based upon three year moving average with dampening factor of 3.

A10.134 The 2016/17 volume for GEA Bandwidth Changes was substantially higher than previous years, due to mass migration of customers to higher bandwidths. Although we might expect the occasional spike in bandwidth changes, we do not consider it appropriate to speculatively assume a spike in a specific year within the charge control period. Therefore, we have modelled the 2016/17 bandwidth changes volume to equal the 2015/16 actual.

A10.135 Furthermore, we find that the use of a dampening factor greater than 1.4 is appropriate (as well as the adjustment to 2016/17 actuals) as the use of 1.4 would result in excessively high forecasts for bandwidth changes as a proportion of forecast GEA rentals. We continue to consider that the use of a dampening factor of 3 results in realistic forecasts that increase as the number of GEA rentals increases.

GEA commercial ceases

A10.136 For GEA ceases, we have found that the commercial conversion factor (based on actuals) is higher than that for GEA rentals. We consider it likely that commercial areas will continue to have a greater proportion of GEA ceases. This is because customers in subsidised areas are less likely to cease fibre services on Openreach's network given the limited availability of competitive networks in those areas.

A10.137 In the March consultation, we proposed to estimate the GEA ceases commercial conversion factor by multiplying the conversion factor for GEA rentals by 1.05. However, the 2016/17 actuals suggest that 1.05 would underestimate the number of commercial GEA ceases over the charge control period. In light of this evidence, we consider that multiplying the conversion factor for GEA rentals by 1.1 is more appropriate for forecasting. We note that for some previous years, multiplying the rental commercial conversion factor by 1.1 would result in a figure above 100%, which is unlikely to occur in

[71] This is in line with our assumption of a decreasing proportion of fibre services that are internally consumed.

the real world. Therefore, we have multiplied the conversion factor for GEA rentals by 1.1 and set a cap on the commercial split for GEA ceases at 100%.

A11. Top-down model: general approach

A11.1 This annex sets out the approach we have taken to estimating the cost based charges for MPF services over the charge control period from 1 April 2018 to 31 March 2021. In addition, the top down model allocates common costs between copper and GEA-FTTC services based on the long-run incremental costs (LRIC) for GEA services calculated in the bottom-up model (see Annex 14).

A11.2 We set out our decisions below on how we forecast costs, including common costs, within the top-down model. Where relevant, we discuss and respond to stakeholder views raised through our consultations. We discuss:

- the design of the top-down model;
- treatment of common costs in the top-down model; and
- how we calculate the 'X' value for our CPI-X control.

A11.3 In Annex 12, we set out in detail the adjustments that we have made to costs in the top down model, both in the base year (which is the starting point for our forecast costs) and over the forecast period.

A11.4 With regards to our general approach to top-down modelling, stakeholders only commented on our approach to forecasting and allocating common costs which we discuss in the relevant section below.

Introduction

A11.5 As set out in Volume 2, Section 2, we have decided to use a top-down model based on an efficient ongoing national copper network (providing WLA and WFAEL services) alongside a bottom-up model[72] of an overlay FTTC network (providing GEA services). This annex details the general approach we adopted in our top-down model, which we have used to estimate the cost of MPF Service Level 1 rentals and ancillary services.

A11.6 The top-down model is based on the current cost accounting (CCA) approach that uses financial capital maintenance (FCM) and the fully allocated cost (FAC) standard. We use base year data from BT's Regulatory Financial Statements (RFS) which we assess and adjust in the Base Year Model (which is one part of our top-down model).

A11.7 The top-down model calculates how the nominal costs of relevant services will change over the period of the charge controls. The top-down model is ultimately used to calculate the values of X for a CPI-X glidepath for the services (and baskets of services) in the charge controls. In order to do this, the top-down model forecasts:

- Total common costs associated with BT's WLA and WFAEL services. These are the costs shared between WFAEL (WLR) and WLA (LLU and GEA) services which cannot be

[72] Our bottom-up modelling is explained in Annex 14.

attributed directly to them. As explained below, we define common cost as the difference between BT's FAC and the LRIC.

- LRIC for BT's copper WLA and WFAEL services including LLU and WLR rentals, connections, migrations and other relevant ancillary services. We have relied on outputs from BT's LRIC model for this calculation.[73] We calculate the LRICs for GEA services using our bottom-up FTTC model which we then use as an input to the CPI-X model.

Top-down model design

Approach to top-down modelling

A11.8 In our top-down model we use accounting information to forecast how BT's efficiently incurred costs will change over time relative to the base year. The top-down model is constructed around the costs and volumes of network components[74] and estimates how unit costs change over the forecasting period.

A11.9 We calculate the cost for each of Openreach's services (e.g. MPF Rental) using the costs of several underlying network components (e.g. E-side copper capital). Some network components are shared across many different services (e.g. network components that include duct costs), while others are consumed by a smaller set of services (e.g. network components that include equipment costs for specific services).

Level of aggregation used in the top-down model

A11.10 In the 2016/17 RFS, BT reported the costs of regulated WLA and WFAEL services on what it refers to as a service level and a network component level. Both measures have been subject to a degree of aggregation by BT. In building the top-down model, we considered the appropriate level of aggregation to use.

A11.11 Our general view is that the use of more disaggregated input data is likely to provide more accurate forecasts of costs. Thus, we forecast network costs on a component basis (rather than a super component basis)[75] in the model.

A11.12 For some services, BT records volume and pricing data based on individual services, but we understand that it is not always possible for BT to provide cost and usage factor data to the same level of disaggregation.[76] Thus, in the model we have forecast costs at the basket level, which implicitly assumes the mix of service variants within service groups will remain

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[73] BT models the LRIC for each of its network components and then provides its estimates to Ofcom as part of its AFIs.
[74] See Section 12 of BT, *Accounting Methodology Document (AMD) 2017*. http://www.btplc.com/Thegroup/RegulatoryandPublicaffairs/Financialstatements/2017/AMD2016-17.pdf.
[75] The network components reported in the RFS are super-components, which are made up of more detailed network components. Therefore, the reported super-component unit cost in the RFS is a weighted average of the unit costs of its constituent network components.
[76] This is because BT's regulatory cost system, REFINE, uses broadly the same level of service disaggregation as reported in the RFS.

constant over the forecasting period. In order to ensure that revenues are forecast on the same basis as costs, we have aggregated the volume and pricing data to the basket level.

A11.13 In summary, we have modelled costs at the most disaggregated level that we considered appropriate (i.e. at the component level) whilst we have modelled revenues at either the service or basket level.

Base Year Model

A11.14 The starting point when modelling a charge control using a top-down approach is to establish a relevant cost base, which we refer to as the base year costs for the charge control. We calculate our base year costs in a standalone model which we refer to as the Base Year Model. The outputs of the Base Year Model are used as inputs into our CPI-X model (as discussed further below).

A11.15 Our established practice is to use the most recently available, audited information underlying the RFS as the base year data for our top-down charge control models. Accordingly, we have used cost data from BT's 2016/17 RFS. We have updated our base year from our March consultation where we used data from BT's 2015/16 RFS.

A11.16 The data supplied by BT in response to our information requests has provided us with detailed disaggregated cost data that have been derived from the 2016/17 RFS. BT has provided disaggregated financial information for 2016/17 on a network component basis for WLA and WFAEL services at the same level of aggregation as those reported in the 2016/17 RFS. As discussed in Annex 12, we have made various adjustments to the base year data in order to use them for forecasting.

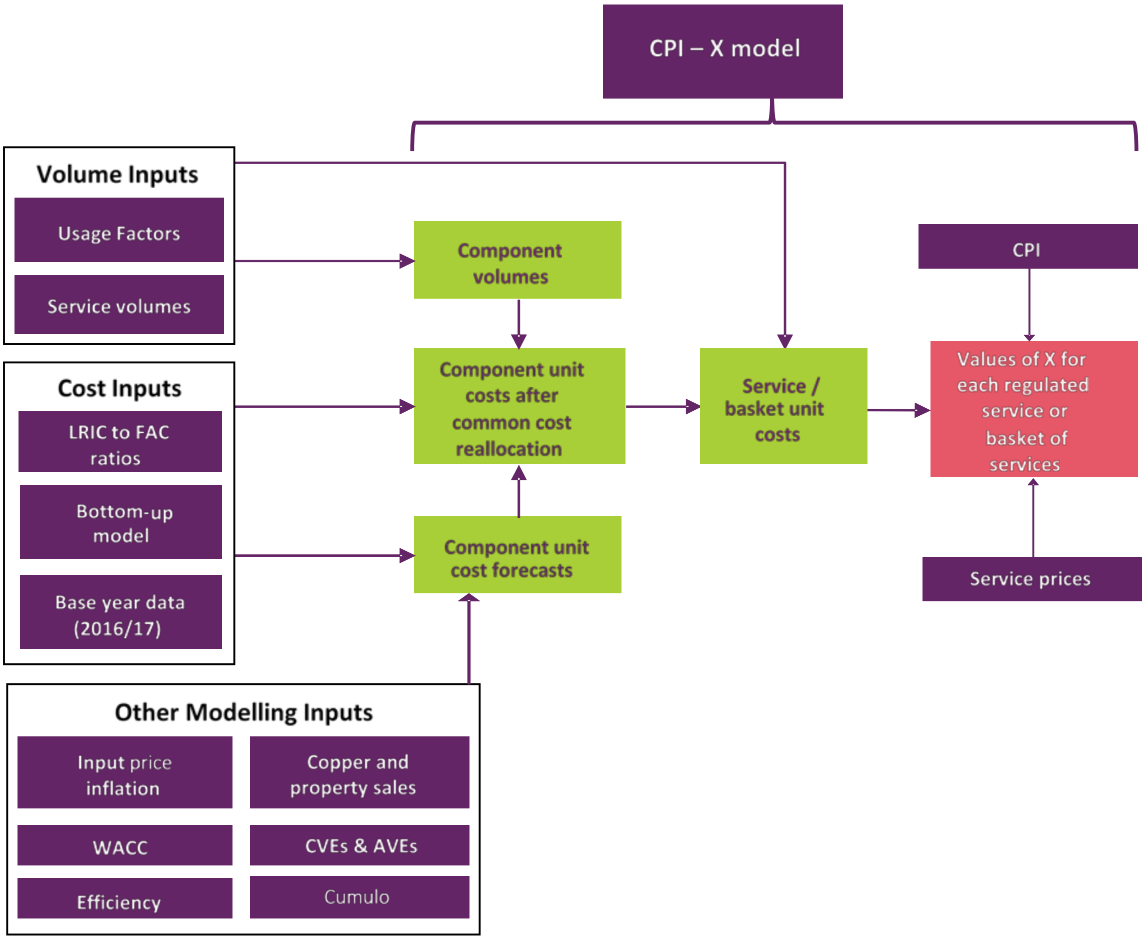
CPI-X model

A11.17 The CPI-X model performs the following six key calculations:

- Step 1: Forecast service volumes over the modelling period using the outputs of the Volumes model.
- Step 2: Convert service volumes to Network Component volumes using service usage factors to determine network component volume growth rates.
- Step 3: Calculate forecasts of the capital costs and operational expenditure (opex) for each network component using the base year costs and applying estimated asset price changes, efficiency forecasts, as well as AVEs and CVEs combined with network component volume growth rates.
- Step 4: Calculate future service costs based on the amount of each network component that a given service uses (i.e. by using the usage factors).
- Step 5: Allocate common costs to reflect incremental cost differences, as well as to reflect any policy decisions.
- Step 6: Calculate the X-values to be used in the CPI-X controls for each service or basket of services, as appropriate.

A11.18 In the following sections we provide more details on Steps 2 to 6. Step 1, forecasting service volumes, is discussed in more detail in Annex 10. The structure for the top-down model is set out in the figure below.

Figure A11.1: Structure of the CPI-X model



Source: Ofcom

Step 2: Forecasting network component volumes

A11.19 The first stage of the top-down model is to apply the service volume forecasts in the volumes model to our calculated usage factors. This determines the total use of each network component based on our service level demand forecasts. Usage factors describe the quantity of each network component used by each product[77] and are also used later in the modelling process for cost allocation from network components to services.

A11.20 We calculate usage factors based upon 2016/17 unadjusted costs, network component volumes, and service volumes. We have cross-checked these usage factors against those

[77] For example, the usage factor of LLU Line Testing Systems for MPF will be 1, as a single line testing system is used in each MPF product.

calculated and provided by Openreach[78] and found them to be broadly consistent.[79] This approach also ensures consistency across the top-down cost and volume models.

A11.21 Generally, we consider it appropriate to apply constant usage factors throughout the period we are modelling because this ensures a consistent basis for forecasting component volume growth. However, we consider it appropriate to adjust our usage factors to take account of the expected changes due to our QoS remedies. Specifically, as QoS standards increase, the relative usage of repair related components that are shared across WLR and MPF will change.[80] We note that this adjustment affects the allocation of shared QoS costs and does not impact the total forecast QoS costs (which is forecast separately as set out in Annex 12).

A11.22 We have therefore adjusted the usage factors for QoS related components and services while keeping the rest of the usage factors constant over time. Furthermore, we have applied adjustments for all three years of the charge control to account for the impact on costs due to the QoS improvements.

Step 3: Forecasting network component costs

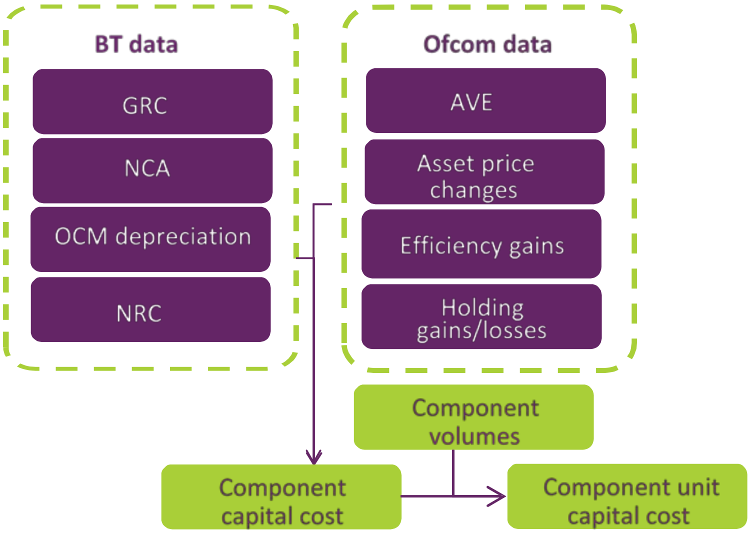
Unit annualised capital costs (on a FAC basis)

A11.23 The next step is to forecast annualised capital costs for each network component for each year of the charge control, and to convert this into network component unit capital costs.

A11.24 The CPI-X model uses the base year adjusted 2016/17 Gross Replacement Cost (GRC), Net Replacement Cost (NRC), Net Current Assets (NCA), and Operating Capability Maintenance (OCM) Depreciation on a network component basis for forecasting network component unit capital costs. For future years, the network component unit capital costs are forecast using network component volume forecasts combined with our assumptions on asset volume elasticities (AVEs), asset price changes and efficiency. This is illustrated below.

[78] Openreach response to the 34th s.135 notice, 8 September 2017.
[79] Furthermore, we believe that any significant differences are due to the adjustments that we have made (e.g. QoS forecasted relative fault rates and service level differentials) or due to different modelled service volumes (e.g. for co-mingling services).
[80] This is because WLR and MPF will have different service level mixes, and the impact of our QoS standards differs depending on service levels.

Figure A11.2: Approach to forecasting network component unit capital costs



Source: Ofcom

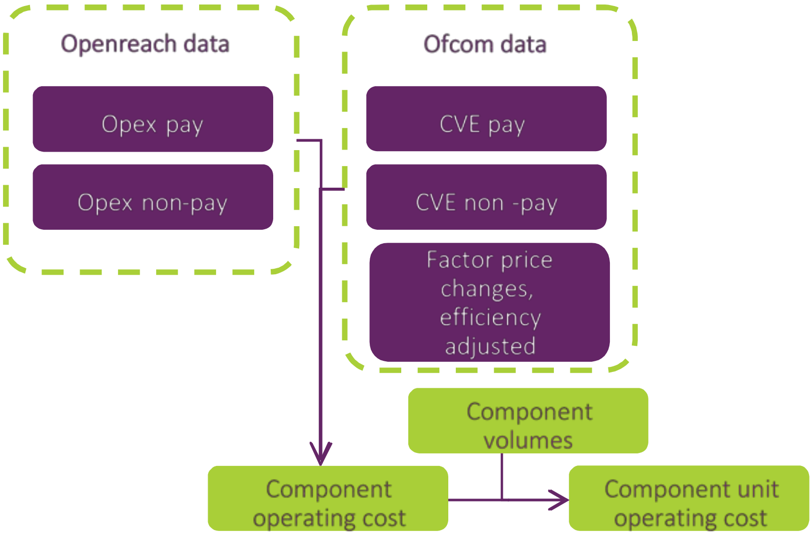
A11.25 We set out the formulae we use to calculate these capital costs in paragraphs A11.79 to A11.84 below.

Unit operating costs (on a FAC basis)

A11.26 In addition to the network capital costs, we forecast the total operating costs per network component for each year of the charge control, and then convert these into network component unit operating costs (i.e. by dividing the total operating costs per network component by the component volumes).

A11.27 The CPI-X model uses the base year adjusted 2016/17 pay and non-pay operating expenditure (excluding cumulo, SLGs, and QoS related repair costs) on a network component basis for forecasting network component unit operating costs. We forecast operating costs using network component volume forecasts combined with our assumptions on cost volume elasticities (CVEs) and factor price changes adjusted for expected efficiency gains. This is illustrated below.

Figure 11.3: Approach to forecasting network component unit operating costs



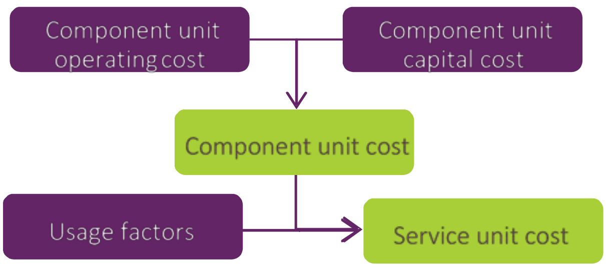
Source: Ofcom

A11.28 We set out the formulae we use to calculate these operating costs in paragraph A11.85 below.

Step 4: Forecasting unit service costs (on a FAC basis)

A11.29 Finally, we combine the forecast network component unit operating and capital costs to obtain total network component unit costs (on a FAC basis). We then apply usage factors to convert network component unit costs into service unit costs. This is illustrated below.

Figure A11.4: Approach to converting network component unit costs into service unit costs



Source: Ofcom

Step 5: Treatment of common costs

A11.30 Once we have calculated the service costs, we need to consider how we allocate common costs. As explained in Section 2, we consider it appropriate to allocate common costs between MPF and GEA services based on an equi-proportional mark-up (EPMU) approach.

A11.31 In order to achieve this, we first explain below how we have forecast service LRICs for copper services and then set out how we have forecast common costs currently allocated to GEA. Finally, we set out how we have allocated common costs across the different services within the charge control models.

Forecasting LRICs

Our proposals

A11.32 In order to forecast the LRICs for copper services, we proposed to estimate the proportion of forecast FACs that are incremental in the long-run, i.e. the LRIC to FAC ratios. We relied upon the bottom-up model's LRICs for GEA services.

A11.33 In the September 2017 top-down model, we proposed using a different weighting for each year based on the in-year breakdown of costs by FCM depreciation,[81] operating costs[82] and return on capital employed (ROCE). We still used the base year LRIC to FAC ratios for each of these cost types, but the overall component LRIC to FAC ratio was dependent on the forecast breakdown of FAC by FCM depreciation, operating costs and ROCE. Vodafone and Openreach commented on our approach to forecasting LRICs.

Stakeholder responses

A11.34 Vodafone was concerned about the reliability of BT's LRIC model, in particular the transparency of the model.[83] Openreach requested clarifications on our approach and highlighted a discrepancy in the forecast FAC, suggesting that based on the figures provided the overall costs have reduced by £[✂].[84]

Our reasoning and decision

A11.35 The top-down model first determines forecast LRICs at a component level then uses usage factors to convert these into service level LRICs, consistent with how it determines service level FACs. The component level LRIC to FAC ratios are based on a weighted average of the operating cost[85] LRIC to FAC ratios and the capital cost[86] LRIC to FAC ratios.

A11.36 We note, with respect to Vodafone's concern about BT's LRIC model, that copper AVEs and CVEs have been published to two decimal places and this has occurred across multiple charge controls over time. Therefore, stakeholders have had the opportunity to assess our modelled LRICs and provide comments and evidence regarding our proposals. In addition, we have relied upon our bottom-up model, which was published as part of our March

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[81] The FCM approach seeks to maintain the financial capital of the firm, and thus the firm's ability to continue financing its functions. For modelling purposes, this involves including an allowance within the capital costs for the holding gains or losses associated with changes over the year in the value of the assets held by the firm.
[82] In the top-down model, we aggregate pay and non-pay costs in 2016/17 and forecast total operating costs (rather than forecasting pay and non-pay separately). Therefore, we consider it appropriate to use the weighted average 2016/17 CVE.
[83] See Vodafone's response to the September 2017 WLA Consultation, response to Question 4.7.
[84] See Openreach's response to the September 2017 WLA Consultation, paragraphs 61-66.
[85] This includes pay and non-pay costs. The ratios in the CPI-X model (see the "Parameters" spreadsheet) will exclude cumulo, SLGs, and QoS related repair costs, consistent with the fact that these costs have been excluded from the base year. However, we reintroduce these costs in the CPI-X model prior to calculating common costs, and thus they still have an impact on the allocation of common costs.
[86] This includes FCM depreciation and ROCE, which have significantly lower LRIC to FAC ratios than pay and non-pay costs.

consultation to determine GEA LRICs. We discuss the issue of the asymmetry of information more generally in Section 4.

A11.37 In response to Openreach's comments, we confirm that we have used LRIC to FAC ratios for FCM depreciation (rather than OCM depreciation) and the LRIC to FAC ratios for ROCE are based upon NRCs whilst the AVEs are based on GRCs.[87] Finally, we confirm that this approach does not impact the total costs within the top-down model. We find that BT's calculated £[✂] shortfall was based on several incorrect assumptions.[88]

A11.38 We continue to consider that our approach is appropriate as the forecast LRICs are based on the best available information. In addition, this approach is consistent both with the top-down model's forecast breakdown of capital and operating costs[89] and the cost forecasting approach in the 2016 Leased Lines Charge Control.[90]

Forecasting GEA common costs

Our proposals

A11.39 In our March consultation, we proposed separately forecasting common costs that are currently attributed to GEA services. We found that BT's Network Component Costs (which are an aggregation of different network cost elements) do not easily map onto the bottom-up model's network elements. This meant that there was a risk of inconsistency when comparing the bottom-up model's network component LRICs to BT's network component FACs.

A11.40 We noted that it is possible to further aggregate BT's cost components such that a reasonable comparison can be made with the network elements used in the bottom-up model. However, we would then need to ensure consistency across multiple elements of the top-down and bottom-up models which would have resulted in greater model complexity (e.g. use LRIC to FAC ratios to determine GEA specific component AVEs and CVEs for each year, determine efficiency rates for GEA common costs that are consistent with the bottom-up model estimates). We did not consider that this approach would lead to significantly different forecast unit costs, nor that these forecasts would necessarily be more accurate. We therefore proposed applying our simplified approach as we considered this was more proportionate and transparent.

[87] We consider NRC to be a good proxy for MCE, given the relatively small magnitude of NCA, thus we consider NRC to be an appropriate cost category for determining LRIC to FAC ratios for ROCE. We note that AVEs are applied to GRCs thus it is appropriate to calculate AVEs using the LRIC to FAC ratios for GRC.

[88] We note that in its calculations BT had not included the forecast increase in WLR LRIC+ and only considered the reduction in commercial GEA LRIC+, when in fact it should have applied the unit LRIC+ reduction to national volumes.

[89] This is important as capital costs tend to have significantly lower LRIC to FAC ratios than operating costs so capturing the future breakdown of FAC by capital and operating costs will result in a more consistent estimation for the weighted average LRIC to FAC ratio.

[90] In the top-down cost model for the LLCC, we forecast the LRICs and FACs by component and by capital and operating costs separately before aggregating to overall component costs. This meant that the component LRICs reflected the weighting of operating and capital costs for each modelled year. See the CPI-X model for the 2016 LLCC https://www.ofcom.org.uk/consultations-and-statements/category-1/business-connectivity-market-review-2015.

A11.41 Therefore, we did not propose to forecast GEA service level FAC in the same way as we do for copper services in the CPI-X model.[91] We proposed forecasting GEA LRICs within the bottom-up model, and separately forecasting common costs currently attributed to GEA in the CPI-X model, which are then reallocated using EPMU.

Stakeholder responses

A11.42 Both Sky[92] and TalkTalk[93] argued that our approach to forecasting GEA common costs would result in any forecast efficiency in the bottom-up model being reflected in higher GEA common costs (i.e. there would be no efficiency savings in our forecast GEA FAC estimates).

Our reasoning and decision

A11.43 As set out in Annex 14, we have built a bottom-up model that forecasts the costs faced by a hypothetical efficient operator when building and operating an FTTC overlay network. We have used this model to estimate the LRIC for GEA services provided by Openreach.

A11.44 We continue to consider it is appropriate to use BT's 2016/17 FAC, with the Base Year adjustments, and 2016/17 LRIC from the bottom-up model to determine the base year GEA common costs. This ensures that BT is given the opportunity to recover its FAC whilst also incorporating our estimate of GEA LRIC, and thus any associated forecast cost savings found within the bottom-up model. Therefore, we disagree with Sky and TalkTalk and find that our approach allows any cost savings found in the bottom-up model to be incorporated into the top-down model.

A11.45 We note that the bottom-up LRIC will only impact the GEA common cost forecast by determining the amount of common costs attributed to GEA in 2016/17.[94] We then forecast how these common costs will change over time, in a consistent manner as we treat the common costs currently attributed to copper services.

A11.46 In order to estimate costs at the end of the charge control period, we need to apply forecasting assumptions to the 2016/17 GEA common cost. We have applied a weighted average annual efficiency rate and price inflation, based on the 2016/17 breakdown of the GEA common cost stack.[95]

A11.47 For the annual efficiency rate, we have assumed no efficiency rate for ROCE and depreciation.[96] We have applied the top-down model's opex efficiency rate, weighted by

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[91] In other words, for the GEA specific components in the CPI-X model, we do not consider the stated AVEs/CVEs, input price changes, or efficiency figures to be appropriate. In particular, we have attempted to exclude GEA services when estimating efficiency thus the efficiency rate in the CPI-X model is likely to not be appropriate for GEA specific costs.
[92] Sky response to our March 2017 WLA Consultation, Annex 3.
[93] TalkTalk response to our March 2017 WLA Consultation, paragraphs 7.37-7.38.
[94] Our approach calculates common costs currently attributed to GEA, consistent with both the bottom-up LRIC and BT's RFS FAC.
[95] We note that costs can be broken down into pay, non-pay, and capital costs. For each of these categories, we consider it appropriate to apply a different efficiency and inflation rate.
[96] We note that the top-down model assumes a capex efficiency. The cost savings associated with capex efficiency only applies to new assets and thus it takes time for this cost saving to be reflected in BT's costs. We consider it reasonable, as a

the proportion of GEA common costs that are opex. This results in a weighted average efficiency rate of around 1%.

A11.48 For the annual price inflation, we have assumed RPI for the capital cost element of the 2016/17 GEA common cost[97] and a weighted average opex price inflation.[98] This results in a weighted price inflation of around 1% (which varies year on year in line with the forecast variations in RPI and opex inflation).

A11.49 We note that the top-down model only applies RPI inflation to duct and copper assets in the access network, yet we have applied RPI to the total capital cost for GEA common costs. We note the difficulty of mapping the bottom-up model's network elements with BT's MCE asset categories but consider it likely that the GEA common costs that we calculate primarily consist of duct and copper assets.[99]

A11.50 We assess the GEA common costs at the service level and we consider it appropriate to calculate and then attribute national[100] GEA common costs across national GEA service volumes. We have applied a pro rata uplift to our estimate of base year FTTC common costs to account for common costs allocated to FTTP.[101]

A11.51 We have also forecast the total LRIC for GEA ceases (using our volume forecasts and bottom-up LRIC), and added this forecast total LRIC within the GEA common cost forecast. This is because we are setting the price for GEA Ceases at zero, so we need to ensure that the FAC for GEA ceases is recovered within the rentals, rather than just the common cost for GEA ceases.

Common cost allocation in the top-down model

Our proposals

A11.52 In our March consultation we defined common costs as costs that are shared between WLR, LLU, and GEA services which cannot be attributed directly to these services, i.e. they are costs that cannot be attributed to the service level increment. We proposed not to reallocate common costs that are currently allocated to other markets to our charge controlled services. We considered it likely that to do so could undermine our ability to set

modelling simplification, to assume no efficiency for the purpose of forecasting common costs that are allocated to GEA, particularly given the relatively small magnitude of these costs.

[97] We do not consider it appropriate to apply RPI to fibre related assets. However, given that we consider these costs to be common across the market, it is consistent to assume that they will primarily be copper and duct related costs (for which we consider RPI to be the appropriate asset price inflator).

[98] The opex price inflation is based on the pay and non-pay price inflations assumed in the top-down model. As a modelling simplification, we estimated the weighted average opex price inflation based on the pay and non-pay split for BT's GEA FAC. We found that BT's FAC and the bottom-up model's LRIC suggest broadly similar breakdowns of opex for pay (around 70%) and non-pay.

[99] We consider it likely that most of the GEA common costs are duct and copper based given that most of the bottom-up LRIC consists of other costs (e.g. equipment, cabinet, and exchanges).

[100] National volumes include all wholesale services sold by BT in the UK. This is distinct from commercial volumes which exclude FTTC services that are based on subsidised cabinet roll-out (e.g. BDUK funded cabinets).

[101] In our modelling, we have assumed FTTP service volumes to be FTTC, which means that total common costs from FTTC (actuals) does not include total common costs from GEA.

charges that incentivise efficient investment. However, we proposed to reallocate some costs within the WLA and WFAEL markets.

A11.53 We considered it appropriate to give BT the opportunity to recover its efficiently incurred costs as forecast in the CPI-X model. Therefore, we proposed reallocating the cost for services whose charges are set below our forecast FAC to then be recovered via WLR, MPF, and GEA rentals.

Stakeholder responses

A11.54 Several stakeholders commented on our calculation and approach to allocating common costs in response to our March consultation. Both Sky[102] and TalkTalk[103] argued that certain components should be excluded when calculating common costs, specifically that certain costs (e.g. those allocated to the 'Analogue Line Cards' component) should not be allocated to fibre services. CityFibre considered all common costs should be allocated to fibre services to better promote investment in competitive networks.[104]

A11.55 Both TalkTalk and Vodafone discuss the possibility of over recovery due to the weighting between products. Vodafone said that our calculation may mean that "if BT sells higher volumes of higher speed services, then common costs maybe over recovered"[105] whilst TalkTalk noted "retaining the weighting between products at future charge controls, as proposed at §2.47 of Volume 2 of Ofcom's Consultation is problematic, as it risks significant levels of over-recovery for BT".[106]

A11.56 TalkTalk reiterated comments it made in response to the Narrowband Market Review that "additional duct costs should be allocated to ISDN products" as this would "remove supernormal profits obtained by BT on ISDN products, yet allow BT to recover its costs".[107]

Our reasoning and decision

A11.57 We continue to define common costs as the difference between BT's FAC and LRIC. In Volume 2, Section 2, we have set out the cost standards (i.e. LRIC or FAC) for the services that we are charge controlling. We continue to consider it appropriate to reallocate any efficiently incurred costs that would otherwise not be recovered due to setting charges below BT's FAC. The overall costs to be reallocated across services is made up of:

- The common cost forecasts for services that we have decided to set at LRIC;
- The FAC for services that we have decided to set at zero; and
- The common cost forecasts for rental services (WLR, SMPF, MPF, and GEA).[108]

A11.58 We address CityFibre's comments in our economic principles section (Volume 2, Section 2) but to summarise, we did not consider allocating all common costs to fibre services was

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[102] Sky response to the March 2017 WLA Consultation, paragraphs 72-76.
[103] TalkTalk response to the March 2017 WLA Consultation, paragraphs 7.13-7.18.
[104] CityFibre response to the March 2017 WLA Consultation, paragraphs 8.6.22-8.6.62.
[105] Vodafone response to the March 2017 WLA Consultation, paragraphs 11.1-11.8.
[106] TalkTalk response to the March 2017 WLA Consultation, paragraph 7.6.
[107] TalkTalk response to the March 2017 WLA Consultation, paragraph 6.31.
[108] We note that we also include the DPA related costs within the total common costs to be reallocated, as set out in detail in Annex 12.

appropriate, not least because it might negatively impact customer switching to fibre services.

A11.59 In light of stakeholder responses, we have further assessed the breakdown of common costs in the WLA and WFAEL markets. We found that most of the common costs attributed to service specific components, such as Analogue Line Cards for WLR, is from general accommodation or management costs (which we consider to be common across the access network).

A11.60 We did find that a significant amount of common costs came from the capitalised and maintenance related costs of the E-side copper asset. GEA services do not directly utilise the copper found in the E-side of the network. However, this copper is currently required for testing purposes, regardless of whether a WLR, MPF, or GEA line is consumed. Therefore, we consider it appropriate to consider the FAC minus LRIC for the E-side copper asset to be a cost necessary for all WLA and WFAEL services (i.e. common).

A11.61 We recognise that a proportion of common costs for certain components may be specific to copper, i.e. WLR and MPF, but we consider it likely that this is a small proportion of the total calculated copper common costs. Furthermore, it is also possible that some of the GEA common costs (e.g. total LRIC for GEA ceases) are specific to fibre, yet these are included in the overall common cost figure. We also note that a more disaggregated breakdown of costs would add further complexity to the model. Overall, we consider it unlikely that using a more disaggregated breakdown of costs would result in an improved allocation of costs between copper and GEA services.

A11.62 In order to calculate the common costs currently attributed to copper services, we have calculated the sum of the difference between total LRIC and total FAC for services that we set at LRIC and the three copper rental services (MPF, WLR and SMPF). For common costs that BT has allocated to fibre services, within its regulated accounts, we have separately calculated a figure as set out in the sub-section above.

A11.63 As set out in Section 2, our estimate of common cost includes the costs associated with some services that we have decided not to charge control (e.g. WLR and SMPF rentals). This is because we consider it appropriate to align the allocation of common costs across all copper rentals. In addition, we consider it appropriate to use an EPMU approach to allocate common costs across copper (i.e. WLR and MPF) and GEA-FTTC services. This results in a LRIC+ control on both MPF and GEA services.

A11.64 In order to determine the proportion of common costs to be allocated to GEA, the EPMU approach uses the proportion of total forecast LRIC for WLA and WFAEL rental services[109] that is due to GEA in any given year. We have then allocated the remainder of common costs to copper rental services.

A11.65 For example, if the amount of common costs to be allocated was £50 million, total forecast LRIC for WLA and WFAEL rentals was £100 million, and the forecast LRIC for GEA was £50

[109] Note that this is calculated as the unit LRIC for each rental service (i.e. WLR, SMPF, MPF, and GEA) multiplied by the relevant volumes for each rental service.

million (i.e. 50% of the total), then GEA rentals would be allocated £25 million of common costs (i.e. 50% of £50 million).

A11.66 We note that our estimate of the total GEA LRIC uses national, rather than commercial only, volumes given that our charge control on GEA is on a national basis.[110] Consistent with this, we have allocated the GEA common costs across national GEA volumes.

A11.67 Having allocated common costs to copper services using the EPMU approach, we consider it appropriate to then allocate these common costs across WLR and MPF rental services on an equal per line basis.[111] We have then divided this copper common cost by the total number of WLR and MPF lines. This allocation of copper common costs is as we proposed in our March consultation, and is consistent with our approach in the 2014 FAMR Statement. This results in £31.57 of common costs being allocated to MPF Rentals on a per line basis in 2020/21.

A11.68 Having allocated common costs to GEA services using the EPMU approach, we consider it appropriate to then allocate these common costs across different GEA services in line with the existing price ratio of BT's GEA-FTTC charges. The pricing ratios for GEA-FTTC are shown in the table below.[112] Furthermore, we have calculated the forecast GEA 40/10 charge such that, if BT were to maintain the existing ratio of prices relative to our control on GEA 40/10, and based on our volume forecasts, it would recover its efficiently incurred costs across all fibre services.

Table A11.5: GEA-FTTC prices relative to 40/10 GEA-FTTC rental

	GEA FTTC 40/2	GEA FTTC 40/10	GEA FTTC 55/10	GEA FTTC 80/20
Price relative to 40/10 GEA-FTTC	93%	100%	114%	134%

Source: Openreach's FTTC price list as of 31 January 2018.

A11.69 TalkTalk suggested that we reallocate duct common costs from our charge controlled services into ISDN markets. As set out in the March consultation, we were concerned that reallocating common costs between markets could lead to us sending inefficient pricing signals.

Step 6: Calculation of the X

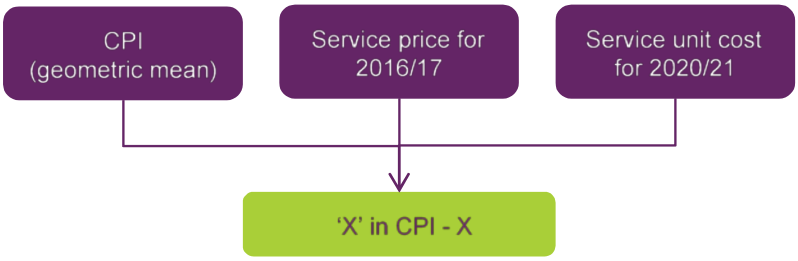
A11.70 As explained in Volume 2, Section 3, our charge controls use an adjusted glidepath that set prices equal to our estimate of costs in 2019/20 and then follow the forecast cost trend to 2020/21.

[110] We calculate the unit LRIC for GEA services on a commercial basis, but find that the subsidy received by BT in subsidised areas results in a national unit cost (net subsidy) that is very similar to the commercial unit cost.
[111] Note that this implies no common costs are allocated to SMPF rental services. We note that BT's pricing flexibility for WLR and SMPF means that it can recover a proportion of the common costs that we have allocated to WLR rentals from SMPF rentals instead.
[112] We consider this is the best available approximation on how BT may price its higher and lower speed services.

A11.71 In order to determine the X-values required for these glidepaths, we calculate the "original X-value" (i.e. as if the charge control applied at the start of 2017/18) for individual services using the following inputs for each product, as illustrated below:

- charges in nominal terms (as adjusted for common cost allocation) in 2019/20;
- the CPI geometric mean (for the period 2017/18 to 2019/20); and
- service prices in 2016/17.

Figure A11.6: Calculating the value for 'original X-value' in CPI-X for individual services



Source: Ofcom

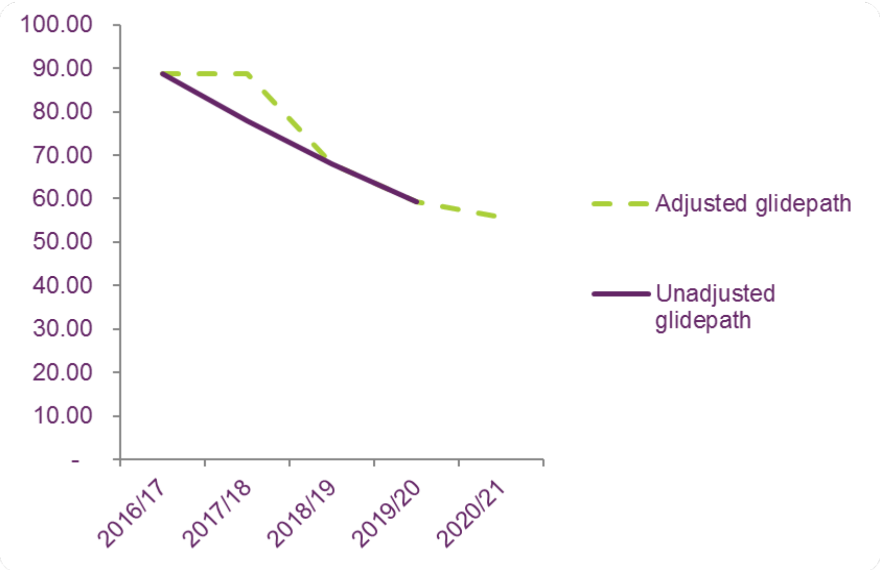
A11.72 The X-values are fixed for the control period and as such they must be based on the forecast for CPI inflation, rather than the inflation figure in the base year. To ensure the correct unit cost target is achieved, the value for X is based on a geometric average of the forecast CPI inflation rates for the period 2017/18 to 2019/20. The geometric average is used to account for the compound effect of inflation as well as the fact that the unadjusted glidepath approach applies the same X for all years.[113]

A11.73 In order to calculate the X-values for our modified glide path, we determine the percentage change required to glide prices at the start of the control (i.e. end of 2017/18) to the 2018/19 forecast charge, as calculated based on the 'original X value' discussed above.[114] We then apply the original X for the subsequent year (2019/20). Finally, we determine the percentage change required to change prices in line with our estimate of the reduction in costs between 2019/20 and 2020/21. This is illustrated in the figure below.

[113] In other words, the use of a geometric average of CPI forecasts is consistent with the same charge control X being applied for all years and ensures that charges equal forecasted costs at the end of the glidepath.

[114] We note that the price for GEA Start of Stopped Line has fallen to £11 which is the same price as GEA CP to CP Migrations. We forecast the same costs for these two services so would expect the same charge controls. However, our general approach results in different charge controls for these services which we do not consider to be appropriate in this case. Therefore, we have modelled the 2016/17 price for Start of Stopped Line to be the same as the 2017/18 price.

Figure A11.7: Illustrative example of adjusted glidepath approach



Source: Ofcom analysis

Baskets of services

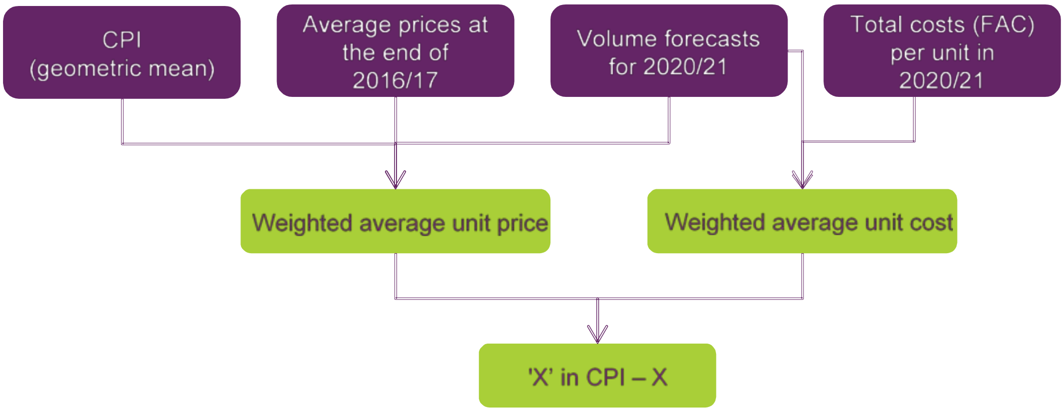
A11.74 The next step is then to calculate the X-values for services that we have aggregated into baskets. As set out in Volume 2, Section 3, we have aggregated various services into charge control baskets.[115]

A11.75 Most of these baskets are incorporated into BT's accounts (i.e. these services have already been incorporated into the cost, revenue and volume data provided). However, we have separately forecast costs for the co-mingling services and then aggregated these unit costs into a Co-mingling New Provide and Rental basket (as found in BT's RFS).

A11.76 We have calculated the X-value for our service baskets in a similar way as above but taken into account the volume weighting of the individual services within the basket, as illustrated below).

[115] A charge control basket is defined as the group of services that are subject to a common charge control restriction.

Figure A11.8: calculating the value for 'original X-value' in CPI-X for baskets of services



Source: Ofcom

A11.77 We have calculated the X-values for our modified glide path for baskets of services using the approach set out above for individual services.

Detailed approach to forecasting FAC

A11.78 We set out above our general approach to top-down modelling. We now provide greater detail of the forecasting approach for network component costs. We consider BT's efficiently incurred costs will include the cost of:

- acquiring assets that are used to provide its services (capital costs or capex); and
- operating those assets and providing the services more generally (operating costs or opex).

A11.79 The table below sets out the abbreviations used in the cost forecasting equations.

Table A11.9: Abbreviations used in cost forecasts

Abbreviation	Description
SS	Steady state
Add	Additional (i.e. volume dependent)
Total [x]	Steady state [x] + Additional [x]
CVE/AVE	Cost-volume elasticity or Asset-volume elasticity
Eff	Efficiency change (as percentage)
[Cost category] (t)	Cost category (e.g. pay related operating costs) in time period t (i.e. in-year)
IPC (t)	Input price change (%) in time period t

Source: Ofcom

A11.80 As set out above, we have forecast capital costs and operating costs separately. We discuss each in detail below, setting out the terminology used as well as the forecasting equations found in the CPI-X model. Annexes 17, 18, and 19 provide details on the AVEs and CVEs, efficiency and input price changes we use to forecast operating and capital costs.

Forecasting of capital costs

A11.81 As set out in Section 2, we have decided to use the CCA FAC cost standard for calculating the total WLA market level cost. We adopt the FCM approach to CCA for establishing the allowed capital costs for BT.

A11.82 The FCM approach seeks to maintain the financial capital of the firm, and hence the firm's ability to continue financing its functions. For modelling purposes, this involves including an allowance within the capital costs for the holding gains or losses associated with changes over the year in the value of the assets held by the firm. This is in addition to an allowance to undertake the capital expenditure (capex) required to retain the output capability of the firm's assets.

A11.83 We split our forecast capital costs into 'steady state' (i.e. no volume changes) and 'additional' (i.e. allowing for changes in volumes) and calculate these separately. The purpose of steady state capex is to replace the assets that have come to the end of their life over the year, and thus disposed of. This capex ensures that the output capability of the firm and the average age of its assets are unchanged when volumes are not changing. Additional capex on the other hand represents the incremental changes that a firm makes to its steady state asset base to meet changes in demand.

A11.84 Steady state and additional capex interact in the following ways:

- Both steady state and additional (positive and negative) capex are derived from the gross replacement value (GRC) of the firm's asset base. This implies that steady state and additional capex (be that positive or negative) all relate to the purchase of new assets.[116]
- When service volumes increase, the firm increases the size of its asset base in order to serve these volumes by investing in positive additional capex on top of its steady state capex.
- When service volumes decrease, the firm decreases the size of its asset base by means of a flow of negative additional capex on top of its steady state capex (i.e. it replaces new assets at a slower rate than it is disposing of old assets).

A11.85 For modelling purposes, negative additional capex is either where the firm forgoes investing in steady state capex or where it disposes some of its assets, i.e. additional disposals:

[116] In the base year, BT's steady state capex is set equal to OCM depreciation, which is a function of the GRC of the firm's assets. In subsequent years, steady state capex is derived from the previous year's steady state capex, accounting for input price changes and efficiency and additional capex is derived from prior year GRC. Both steady state and additional capex are then used to calculate steady state and additional GRC respectively. Steady state and additional GRC are used to derive NRC, and ultimately return on MCE. NRC reflects the value of a firm's assets accounting for the effect of depreciation.

- In the case of the former, modest volume decreases result in positive steady state capex being offset against negative additional capex such that the resulting total (in-year) capex is positive, or at the limit equal to 0.
- In the case of the latter, greater volume decreases mean negative additional capex outweighs positive steady state capex, resulting in negative total capex. The value of negative total capex represents the forecast of additional disposals required to reduce the firm's asset base. This is in addition to the disposals that the firm makes in the steady state.[117] We assume that the modelled firm can realise the remaining value of any asset that is disposed of before it is fully depreciated. We note that our top-down model only forecasts additional disposals for two components (WLA Tie Cables and Wholesale Access Specific).

A11.86 The table below presents the steady state and additional capital cost equations used in the CPI-X model. Steady state capital costs are driven by asset lives, forecast changes in input price and assumed improvements in efficiency. Additional capital costs are driven by volume changes in conjunction with AVEs, as well as asset lives, input price changes and efficiency improvements.

Table A11.10: Equations used to forecast capital costs

Cost	Steady state[118]	Additional
GRC	SS GRC(t) = SS GRC(t-1) * [1 + IPC(t)] + SS Capex(t) – SS Disp(t)	Add GRC(t) = Add GRC(t-1) * [1 + IPC(t)] + Add Capex(t)
OCM dep	We assume straight line depreciation, which we calculate as: SS OCM dep(t) = SS GRC(t) / asset life Where asset life is equal to the ratio GRC/OCM dep in the base year.[119]	Add OCM dep(t) = Add GRC(t)/asset life
Cum OCM dep		Add Cum OCM dep(t) = Add Cum OCM dep(t-1) * [1 + IPC(t)] + Add OCM dep(t)

[117] We consider it appropriate to calculate additional disposals such that they reflect the average remaining asset life. This is because additional disposals will likely be a mix of new and depreciated assets, thus it is inappropriate to base them on capex (which represents new assets only).
[118] Base year values of GRC, OCM depreciation, NRC, and NCA are taken from Openreach's responses to s.135 notices and include our base year adjustments as set out in Annex 12.
[119] We note that we have adjusted the asset lives for some components as part of our HON adjustment, which we set out in detail in Annex 12.

Cost	Steady state[118]	Additional
Capex	Base year capital expenditure is assumed to be equal to OCM dep. Subsequent years are calculated as: SS Capex(t) = SS Capex(t-1) * [1 + IPC(t)] * (1 – eff)	It is assumed Add Capex is required where: SS Capex(t) + Add Capex ≥ 0. Add Capex(t) = total GRC(t-1) * [1+IPC(t)] * AVE * %change vol(t) * (1 – eff)
Disp	Base year disposals are assumed to be equal to base year capex. Subsequent years are calculated as: SS Disp(t) = SS Disp(t-1) * [1 + IPC(t)]	
NRC	SS NRC(t) = SS NRC(t-1) * [1 + IPC (t)] + SS Capex (t) – SS OCM dep (t)	Add NRC(t) = Add GRC(t) – Add Cum OCM dep(t)
NCA	NCA(t) = NCA(t-1) * [1+ volume change %][120]	
HGL	HGL(t) = - [Total NRC(t-1) * IPC(t)]	
Return on capital[121]	Return on capital (t) = [NRC(t) + NCA(t) + HGL(t)] * pre-tax nominal WACC	

Source: Ofcom

Forecasting of operating costs

A11.87 The table below presents the equations used in the top-down model to forecast operating costs. Under our approach, operating cost forecasts are calculated using forecast service volume changes in conjunction with CVEs, as well as forecast changes in input prices and assumed cost savings from efficiency.

Table A11.11: Equations used to forecast operating costs

	Description[122]
Pay	Pay(t) = Pay(t-1) * [1 – eff] * [1 + IPC(t)] * [1 + %volume change(t) * CVE]
Non-pay	Non-pay(t) = Non-pay(t-1) * [1 – eff] * [1 + IPC(t)] * [1 + %volume change(t) * CVE]

Source: Ofcom.

[120] This uses component volume changes. Therefore, we implicitly assume that the unit NCA cost per component does not change over time consistent with the 2014 WLR LLU cost model.

[121] We note that ROCE did not include holding gains in our March and September 2017 CPI-X models. This was highlighted by Openreach (see paragraph 281 of its response to our March 2017 WLA Consultation). Therefore, we have changed our forecasting equation to be consistent with the 2016 LLCC (see paragraphs A26.88-A26.95 of the 2016 BCMR Statement) by including holding gains in the ROCE, given we are using a nominal WACC.

[122] Base year values of pay and non-pay operating costs are taken from Openreach's responses to s.135 notices and include our base year adjustments as set out below. Subsequent years are forecast using the equations set out in this table.

Calculation of total service cost forecasts

A11.88 In order to calculate cost forecasts by service, it is necessary to convert the forecasts of network component costs into service costs. We do this by carrying out the following steps:

- unit network component costs(t) = network component costs(t) / network component volumes(t); and
- unit service A costs(t) = matrix multiplication of unit network component costs(t) and cost usage factors by service A for each of the network components.

A12. Top-down model: forecast adjustments

A12.1 In Annex 11 we set out details of the top-down copper access model that we have used to estimate the cost of MPF services and allocate common costs between copper and fibre services.

A12.2 In this annex we set out the adjustments we have made in our base year data to make it suitable for forecasting and our decisions to make several adjustments to the forecasted costs in the CPI-X model.

Adjustments to the base year data

A12.3 In setting the WLA charge controls we are seeking to model an efficient national commercial operator and, as a starting point, we use BT's costs and volumes as inputs for our model. Specifically, for the purposes of our modelling we have used the 2016/17 base year data received from BT and made eight adjustments to ensure that these costs form an appropriate base for forecasting the efficient level of costs over the charge control period.

A12.4 We scrutinised movement in the 2016/17 base year data compared to 2015/16 to ensure we understood changes in costs for key WLA network components and considered whether the 2016/17 base year cost data:

- Contained any obvious errors or inappropriate accounting methodologies;
- Included any 'one off' costs that should be excluded; and
- Represented BT's costs over the period of the charge control.[123]

A12.5 In considering whether to adjust the base year data it is necessary for us to exercise regulatory judgement based on our understanding of BT accounting data.

A12.6 We have consulted on the adjustments to the 2015/16 base year in our March and September 2017 consultations.[124] The table below sets out the changes that we have decided to make.

A12.7 In the remainder of this section we set out the details of each of the adjustments we have made to the base year data for our cost model. For each adjustment, we set out an explanation of the adjustment and the associated calculation of the adjustment and discuss stakeholder responses to our proposals where relevant.

[123] In the past we would have also needed to check that previous regulatory decisions had been implemented. However, the Change Control process now ensures this is done annually.

[124] We no longer need to correct MPF errors which we proposed in March 2017 as BT has corrected for this error. We also note that since our March 2017 WLA Consultation, we have changed the adjustment we made for service level differentials to instead remove repair related costs.

Table A12.1 Summary of adjustments to our base year model on WLA and WFAEL markets (£m)[125]

Adjustment	Opex Impact (£m)	Mean Capital Employed (MCE) Impact (£m)
2016/17 RFS Total	2,366	9,415
Remove Cumulo costs	[✂] (~81.8)	-
Include restructuring and property provision costs	[✂]	-
Remove subsidised FTTC deployment	[✂] (80-100)	[✂] (550-600)
Remove repair related engineering costs	364	-
Remove Service Level Guarantees (SLGs)	53.1	-
Increase pensions service costs	[✂] (20-40)	-
Tie cables cost adjustment	1.2	115.9
Comingling cost adjustment	2.6	102.8
2016/17 Revised Total	[✂]	[✂]

Source: Ofcom analysis of BT data

Removal of Cumulo costs

Explanation of the adjustment

A12.8 BT's cumulo rate costs are the non-domestic rating costs BT pays on its rateable network assets. As we explain in detail in Annex 21, the rating authorities increased BT's cumulo rating assessment significantly with effect from 1 April 2017. This has led to much higher cumulo costs over the charge control period than BT incurred in our base year, 2016/17.

A12.9 Within the 2014 FAMR Statement, cumulo was forecast in line with the base year costs and expected reductions in these costs up to 2016/17 were captured in our efficiency assumptions.[126] However, we have forecast cumulo costs separately in this charge control, due to the large increase in BT's rates bill. Our treatment of BT's cumulo rates, both how we forecast these over the charge control period and how we attribute these costs to products is described in Annex 21, where we also explain that we do not apply our efficiency assumption to these costs. To avoid double-counting of cumulo costs we

[125] Numbers in red are negative.

[126] Fixed Access Market Review, Volume 2, June 2014. Annexes 16 and 26.

therefore remove all cumulo costs from the base year data and then add them through the Top Down Model. This is set out later in this annex.

A12.10 We proposed making this adjustment in our March consultation and did not receive any stakeholder responses on this proposal. Therefore, we have decided to make this adjustment.

Calculation of the adjustment

A12.11 BT provided us with its operating costs with cumulo reported separately. These costs amounted to a [✂] (~£81.8m) impact on operating expenditure (opex) within the WLA and WFAEL markets.[127] Therefore, we have decided to directly remove these costs from the base year.

Table A12.2 Impact on WLA and WFAEL markets of the cumulo adjustment

Adjustment	Opex Impact (£m)
Remove cumulo costs	[✂] (~81.8)

Source: BT

Inclusion and smoothing of restructuring and property rationalisation provision costs

Explanation of the adjustment

A12.12 Restructuring costs are associated with changes in BT's organisational structure that result in employee redundancies, and are also known as leaver payments.

A12.13 Property Rationalisation provision costs relate to BT's strategy of consolidating its office space to enable the mothballing and subletting of buildings. The cost associated with this rationalisation is treated as a provision. BT makes an annual assessment of the size of the balance sheet provision and its net movement. This assessment will include an element of judgement as to the level of future costs and savings.

A12.14 As part of our review of BT's 2016/17 Statutory Financial Statements for 'one off' items we identified that BT incurred no costs in relation to Property Rationalisation provision costs and Restructuring costs.[128] We noted that both types of cost displayed a high level of volatility, in particular the 2016/17 restructuring cost looked low in comparison to previous years, as shown below.

[127] Openreach's response dated 8 September 2017 to question 4 of 34th s.135 notice.
[128] BT Group plc Annual report and Form 20F, page 189 http://www.btplc.com/Sharesandperformance/Annualreportandreview/pdf/2017_BT_Annual_Report.pdf.

Table A12.3 Restructuring and Property Rationalisation provision costs (£m)

Adjustment	2014/15	2015/16	2016/17
Restructuring costs	315	-	-
Property rationalisation costs	45	29	-

Source: BT Group Plc Annual report & Form 20-F 2017

A12.15 In BT's 2016/17 Statutory Financial Statements, leaver costs were included in Operating costs before specific items and had risen from £8m in 2014/15 to £109m in 2015/16 and £86m in 2016/17.[129] Given that no Restructuring costs were recorded in 2016/17 and 2015/16, this suggested that there were no real costs or that there might have been a change in accounting policy in 2015/16 reclassifying leaver payments within the Restructuring cost specific item to an Operating costs before specific item.

A12.16 We asked BT to provide a breakdown for WLA and WFAEL services for 2013/14, 2014/15, 2015/16 and 2016/17 of the Restructuring and Property Rationalisation provision costs. We also asked what the Restructuring Costs for 2015/16 and 2016/17 would have been had they been accounted for on the same basis as in 2014/15. BT responded that Restructuring costs, if accounted on the basis as in 2014/15, would have been £[✂]m in 2015/16 and [✂]m in 2016/17 across the WLA and WFAEL services.[130]

A12.17 In the 2016 BCMR Statement we considered that the Restructuring and Property Rationalisation provision costs are forward looking and efficiently incurred as they produce future efficiency benefits and reduce future property related costs. As with the 2016 BCMR Statement, we consider that if we were to exclude these costs from the base year then this may lead to lower efficiency assumptions. We proposed including these costs in the base year model in our March consultation and did not receive any stakeholder responses on this proposal. Therefore, we have decided to include these costs.

Calculation of the adjustment

A12.18 Consistent with the 2016 BCMR Statement, given the continued variability of these costs, the amount of discretion that BT has in this process and the lack of transparency of the calculation, for the purposes of modelling our base year costs we have decided to smooth these costs over a three-year period.

A12.19 BT provided network component costs for both the Restructuring Costs and Property Rationalisation provision cost for WLA and WFAEL services for 2013/14, 2014/15 and 2015/16.[131] We combined the three years of data to produce a smoothed three-year average. We then replaced the 2016/17 base year opex data with our smoothed calculation. The impact on WLA and WFAEL amounted to a [✂] increase in respect of

[129] BT Group plc Annual report and Form 20F 2017, page 186.
[130] Openreach response dated 17 January 2018 to question 8 of the 45th s.135 notice.
[131] Openreach response dated 17 January 2018 to question 8 of the 45th s.135 notice.

Restructuring Costs and [✂] increase in respect of Property rationalisation provision, amounting to [✂] in total.

Table A12.4 Impact on WLA market of adjustment for restructuring and property rationalisation costs

Adjustment	Opex Impact (£m)
Smooth restructuring and property rationalisation costs	[✂]

Source: BT

Remove subsidised FTTC Deployment

Explanation of the adjustment

A12.20 In setting the WLA charge controls we are seeking to model an efficient national commercial operator and as a starting point we use BT's costs and volumes as inputs for our model. BT has received public funding (via BDUK) to support its investment in superfast broadband and broadband in hard-to-reach rural areas.

A12.21 BDUK funding and costs are included within the 2016/17 RFS. In our March consultation, we proposed to remove all costs and income associated with the subsidised services and adjust the associated volumes and costs for the commercial services. This was because their inclusion would lead to inaccurate costs for the efficient national commercial operator that we modelled. Stakeholders did not provide any responses on our proposal. Therefore, we have decided to remove these costs and income and adjust the base year GEA service costs to reflect the unit FAC for BT's commercial deployment.[132]

Calculation of the adjustment

A12.22 BT provided a breakdown of the cost of deployed subsidised services in 2016/17, which amounted to [✂] (£80m - £100m) in opex and [✂] (£550m - £600m) in MCE.[133] We have removed these costs from our base year.

Table A12.5 Impact on WLA market of adjustment for Subsidised FTTC Deployment (£m)

Adjustment	Opex Impact (£m)	MCE Impact (£m)
Remove subsidised FTTC deployment	[✂] (80 - 100)	[✂] (550-600)

Source: BT

[132] We have also assessed the difference in unit FAC between BT's commercial and subsidised deployment of FTTC. We found that the unit FACs were broadly similar (a difference of less than 1%).

[133] Openreach response dated 13 September 2017 to question 6 of 34th s.135 notice.

Adjustment for repair related engineering costs

Explanation of the adjustment

A12.23 In the March consultation, we proposed to make an adjustment to reflect how the service level mix would change with the introduction of SML1.[134] However, since BT has now introduced this product, we do not need to make this same adjustment to the 2016/17 base year.

A12.24 We do however think that repair costs are likely to be affected by the expected quality of service improvements as set out in the 2018 QoS Statement. In order to ensure consistency with the calculation of AVEs, CVEs and efficiency rates, we have decided to remove these costs from the base year that feeds into the CPI-X model and have forecast repair costs separately, as described in Annex 13.

A12.25 As per the March consultation, we have identified the costs that would occur when a fault in a WLA service needs to be repaired. We considered that repair costs would be made up of both the direct costs of engineer's time spent on repair and indirect costs associated with repair such as transport and training. Stakeholders did not comment on our proposed approach to calculating repair costs. Therefore, we have decided to continue to include both sets of costs in our calculation.

A12.26 Our approach to calculating repair costs is further explained within Annex 13 of this statement.

Table A12.6 Impact on WLA market of adjustment to remove repair costs

Adjustment	Opex Impact (£m)	MCE Impact (£m)
Remove repair costs	364	-

Source: BT

Adjustment for Service Level Guarantees (SLGs)

Explanation of the adjustment

A12.27 SLGs are contractual payments made by BT to other telecoms providers to compensate for BT's failure to meet agreed performance criteria (such as time taken to complete an installation) set out in the Service Level Agreements. As set out below, we allow BT to recover SLG payments that we might expect given our set service standards and retail automatic compensation.

A12.28 Due to expected improvements in quality of service and increased regulatory requirements (as set out in Annex 13) there is likely to be a change in the dynamics of SLGs that is not reflected within the 2016/17 RFS. For example, in the review period, we expect the

[134] SML1 take up commenced in April 2016.

number of faults to decrease and this to cause the cost of SLG payments to decrease. However, with the introduction of the industry scheme on automatic compensation[135] we anticipate that the compensation cost will increase as telecoms providers negotiate changes to the SLG regime in response to higher payments at the retail level. Due to this change, we have decided to model these aspects separately and therefore they need to be removed from the base year 2016/17 costs.

Calculation of the adjustment

A12.29 In order to calculate this adjustment, we have gathered information from BT in relation to the total SLG payments it made for WLA services in 2016/17 and removed these from our base year costs. According to BT, it spent £53m on SLG payments in 2016/17.[136] We then identified the network components that SLG payments are allocated to. We removed the costs relating to SLG payments from these network components in our base year opex.

Table A12.7 Impact of SLG adjustment on the WLA and WFAEL markets (£m)

Adjustment	Opex Impact (£m)
Remove SLG payments	53.1

Source: BT

Adjustment reflecting the increase in pension service costs

Our proposals

A12.30 In the March consultation, as in previous charge controls, we included the accounting cost of the pension service charge, as reported in the statutory accounts as a measure of the ongoing pension service cost in our cost estimates of the regulated services.

A12.31 In its response to this consultation, Openreach stated that the accounting pension service charge was expected to increase significantly (circa £100m)[137] in 2017/18 due to a "decline in market conditions, our re-assessment of the demographic assumptions and the impact of membership experience adjustments". Openreach estimated this would result in an additional £20-30m pension service cost for WLA services £40m for WLA and WFAEL services). BT had also announced in May 2017 that it was reviewing its defined benefit pension scheme.

A12.32 In our September consultation, we said that in principle we would consider reflecting expected pension cost changes in our modelling. However, we explained that we did not have sufficient evidence to assess the impact of any potential change to these costs. We therefore did not propose updating our pension cost estimates but noted that we may

[135] Ofcom Statement: Automatic Compensation, 10 November 2017: https://www.ofcom.org.uk/consultations-and-statements/category-1/automatic-compensation
[136] BT's response dated 13 September 2017 to question 9 of 34th s.135 notice.
[137] See BT Q4 and full year 2016/17 results. Slide 22. http://www.btplc.com/Sharesandperformance/Quarterlyresults/2016-2017/Q4/Downloads/Slides/q417-slides.pdf.

make an adjustment to the base year costs if further information was available prior to our decision.

Stakeholder responses

A12.33 In response to our September consultation, Openreach agreed that the 2015/16 (and the 2016/17) accounting charge for the ongoing pension service cost may not be a reliable basis for forecasting the ongoing cost over the charge control period. It argued that any increase in pension costs would not be due to a failure of cost control or represent inefficient costs.[138] Openreach proposed that the 2017/18 pension service costs should be used to forecast future pension costs and that a 'true-up' mechanism (similar to what they proposed for cumulo costs) should be used instead.[139]

A12.34 TalkTalk considered that we should await the outcome of BT's review before making any assumptions. However, it noted that if the economic conditions continued to worsen then BT would need to take stronger steps to reduce its pension costs. TalkTalk therefore considered it was "highly unlikely that the combined effect of changed actuarial assumptions and the review of the scheme will be an increase in ongoing service costs – rather it will either stay the same or reduce."[140]

A12.35 Virgin Media highlighted the similarity in the uncertainty of the ongoing pension and cumulo costs and noted that Ofcom should "reassess the consistency of its approach to BT's pension costs and potential for adjustments to the VOA's assessment of RV."[141] It considered we should be consistent on how we "treat adjustments to BT's cost base when the scale and timing of these changes are uncertain and subject to revision."[142] Virgin Media also considered that Ofcom should take full account of any expected changes, provided these costs are "efficiently incurred and can be estimated with an acceptable degree of confidence in Ofcom's regulatory judgement".[143]

Our reasoning and decisions

A12.36 Following our September consultation, BT wrote to all the members of its pension schemes (the BT pension scheme (BTPS) and the BT Retirement Saving Scheme (BTRSS)) to consult on options for reforming the schemes. This consultation closed on 17 January 2018. BT has provided us with its estimates of the costs of these consultation proposals and [✂].[144]

A12.37 On the 5 February 2018, BT announced that it has agreed with the Prospect union to close the BTPS to managers from 31 May 2018. It has also agreed to make some changes to the contribution rates for all managerial staff in the BTRSS. We have therefore taken account

[138] Openreach response to the September 2017 WLA Consultation, paragraph 101.
[139] Openreach response to the September 2017 WLA Consultation, paragraph 105.
[140] TalkTalk response to the September 2017 WLA Consultation, paragraph 3.16.
[141] Virgin Media response to the September 2017 WLA Consultation, page 5.
[142] Virgin Media response to the September 2017 WLA Consultation, page 7.
[143] Virgin Media response to the September 2017 WLA Consultation, page 6.
[144] BT response dated 19 January 2018 to question 4 of the 45th s.135 notice.

of this agreed change (including any transition costs) when estimating our pension service costs over the period of the price control.

A12.38 However, as at the time of this statement "BT is still considering feedback and discussion with the CWU before reaching a final decision".[145] Therefore there remains some uncertainty over the future pension service costs for BT's team members (i.e. employees other than managers).

A12.39 In its response to the September consultation, Openreach suggested that this uncertainty in the future pension operating charge could be addressed by a 'true-up' mechanism. It considered this should be in the form of a 'pass through' cost. Openreach proposed that we adjust the 2016/17 base year to take account of the expected increase in pensions costs in 2017/18 (circa £52m)[146] and then use this pass through mechanism to adjust its costs once the outcome of the negotiations was known.

A12.40 A pass through mechanism (such as the use of CPI inflation in the CPI-X charge control formula) can be an effective way of dealing with uncertainty about future costs in certain circumstances. For example, as a pass through cost CPI has the following desirable characteristics:

- it is exogenous to the firm: the regulated company has little influence over its level;
- it is measurable and transparent: the ONS regularly publishes the latest official values;
- it is predictable: all stakeholders can forecast how it may affect future prices; and
- it can be easily implemented: as CPI changes the value immediately affects prices that are passed through to purchasers of the services within the control.[147]

A12.41 However, we do not agree that the current uncertainty of the ongoing pension service cost satisfies these characteristics and that it may therefore be appropriate to establish a pass through mechanism. The outcome of any negotiations on changes to the BTPS is not entirely exogenous to Openreach and, as is clear from the information provided by BT, it is not predictable and will be hard for stakeholders to predict the impact of any deal. In particular, given the limited information on BT's ongoing pension service costs that would be likely to be publicly available once a deal has been reached.

A12.42 Further to this, it is not clear that any pensions deal would be easily implemented. Under our proposed structure of the charge control (in the March and September consultations), the outcome of the negotiations could only be taken into account at the end of each financial year. So, for example, if an agreement was made within the 2018/19 financial year, any changes to costs would not be able to be reflected in prices until at least April 2019 and more likely April 2020 (as we would likely need to see the impact of the change in pension service costs in the RFS). In addition, we have not put in place a claw back

[145] Press release, 'BT to close defined benefit pension scheme for 10,000 managers', 5th February 2018. https://www.btplc.com/News/#/pressreleases/bt-to-close-defined-benefit-pension-scheme-for-10000-managers-2405030.
[146] Total increase for Openreach.
[147] Within most charge controls, the impact of CPI inflation is only calculated once a year to determine the maximum price or revenue allowed.

mechanism whereby any under/over-recovery on the charge control is recovered in following years.[148] Thus, under Openreach's proposal, if it managed to reduce its costs from the 2017/18 accounting charge, it would keep any savings it was able to negotiate for potentially up to two years.

A12.43 We could address these issues around over-recovery within a year by changing the form of the control. However, this would likely add significant complexity to the charge control and reduce transparency for other stakeholders. In addition, depending on when agreement was reached, if we had increased BT's pension service costs to the level of the accounting charge in 2017/18, we may need to consider the over (or under) recovery of any costs in the next control period. This would not be consistent with the forward-looking nature of the cost estimates on which we need to base our charge controls.

A12.44 In addition, Openreach's proposal would mean that the risk of the final outcome of BT's negotiations with the CWU would be borne by other telecoms providers and ultimately consumers. We consider that, given its future pension service costs are not entirely exogenous to BT, it is important that BT bears some of this risk.

A12.45 However, in light of the changes to market conditions, the deal that BT has agreed with its managers, and having assessed information provided by BT under our formal powers, we consider it appropriate to make a reasonable adjustment to the 2016/17 base year costs to estimate BT's future ongoing pension service costs. Specifically, considering all the evidence in the round, as discussed in paragraphs A12.48-A12.53 below, we consider that an increase in pension service costs of [✂](£20m to £40m) for the WLA and WFAEL markets is an appropriate adjustment to 2016/17 base year costs.

A12.46 [✂]. As discussed below, we have estimated what we consider to be an efficient level of costs associated with the different BT pension schemes. We therefore consider that by making this adjustment to the base year costs we allow BT to recover these efficiently incurred costs from 2018/19.

A12.47 We discuss below our analysis and how we came to determine the level of the adjustment that we consider appropriate. If a deal is reached between BT and the CWU prior to our final statement, we are likely to reflect that in our decision.

A12.48 To assess what BT's actual pension service costs might be for the charge control period, we have used our statutory information gathering powers to request information from Openreach on:

- Its estimates of the ongoing pension service costs and transition costs of the agreement it has reached with the Prospect union with respect to its managers;
- Its estimates of the cost of the two proposals it consulted on for team members, including any transition costs; and
- [✂]

[148] Note this would have been separate from the Excess and Deficiency provisions in our Legal Instruments at Annex 33, which provide for year on year adjustments where BT has under- or over-complied with the charge controls.

A12.49 [✂].

Table 12.8[149] [✂].

A12.50 [✂].

A12.51 [✂].

A12.52 [✂].

A12.53 [✂].

Adjustment for tie cables

Explanation of the adjustment

Our proposals

A12.54 Tie cable services allow telecoms providers to connect their equipment in an Openreach exchange to gain access to the copper access network for LLU. These services include the handover distribution frame (HDF) in a telecoms provider's co-mingling space[150] and services that connect the HDF to the Main Distribution Frame (MDF).

A12.55 As set out within the September consultation, when reviewing Tie Cable costs, we noted that the way BT has historically reported these costs within its RFS is inconsistent with the way tie cable costs have been recovered via Openreach's wholesale charges. We have historically allowed Openreach to recover the labour related costs of connecting the cables within connection charges with the costs of materials used, i.e. the tie cable itself, being recovered within rental charges.

A12.56 Specifically, we noted that costs for Tie Cable connection and rental services (SL128 and SL133) are not currently separately identified within BT's RFS but instead are treated together. Our analysis showed that almost all the costs for these services were capital costs either in the form of depreciation or return on mean capital employed.[151] We found that most of the capital costs were due to BT capitalising both the manpower and material costs associated with tie cables.

A12.57 We proposed that it would not be appropriate to include these historical capitalised labour costs when setting charges for Tie Cables services. We considered it likely that this would lead to over-recovery of costs because these historical capitalised labour costs have already been recovered in historical connection charges. Therefore, we proposed to remove the historical labour installation costs within CL133 from the base year, both from depreciation and mean capital employed. We also proposed to replace these capital costs

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[149] [✂].

[150] Co-mingling space is the space in the BT exchange where the telecoms provider locates its equipment to provide LLU services. The HDF is located within the co-mingling space and is the demarcation point between the Openreach network and the telecoms provider's equipment, where Openreach hands LLU connections to the telecoms provider.

[151] In turn, most of these capital costs are associated with [✂].

with an estimate of the in-year labour operating costs required to install tie cable services in 2015/16.

Stakeholder responses

A12.58 In relation to both the tie cable and co-mingling adjustments, Sky agreed with Ofcom's "direction of travel"[152] but it believed there was insufficient information available for it to comment fully. Sky noted that for these "co-mingling and tie-cables there is a common cause [case] of over-charging – the recovery of costs twice".

A12.59 TalkTalk agreed to the corrections that we proposed regarding both co-mingling and tie cables as they "obviously correct underlying principles" but it considered it difficult to engage in the detail as "the description is limited and it relies to a large degree on terminology" that it did not understand.

A12.60 Further, TalkTalk made a general comment regarding this adjustment that Ofcom "should consider how to address past failure (e.g. through enforcement) and also what action it should take to ensure this does not happen again".[153]

A12.61 UKCTA had "concerns that BT is supplying unreliable cost data that favours BT" regarding both the tie cable and co-mingling issues and that Ofcom should investigate "to make sure all information used is unbiased and isn't giving rise to excess recovery".[154]

A12.62 BT did not comment on the adjustment we proposed to make regarding tie cables.

Our reasoning and decisions

A12.63 We note that both Sky and TalkTalk broadly agreed with the corrections that we proposed to make. In relation to their arguments about their inability to engage in the detail, we acknowledge that this area of our work is very technical and that the detail of our analysis would require a degree of accounting expertise. However, we believe that we have provided adequate information for Sky and TalkTalk to understand the main aspects of our analysis, proposals and decisions. As discussed below, we interrogated the data that BT provided and made sure we used data that was most relevant for our adjustment.

A12.64 Therefore, we have decided to make this adjustment to the 2016/17 base year, as proposed in the September consultation.

Calculation of the adjustment

A12.65 For the September consultation, we asked BT to provide information on historical labour installation costs on tie cables since 2012/13, broken down by connections and rentals. BT was not able to provide this breakdown, but it did provide a breakdown of in year capital expenditure (capex) from 2012/13 to 2015/16 into labour – direct pay and contract pay – and material costs.[155] This suggested that over this period 65-75% of capex attributed to tie

[152] Sky response to the September 2017 WLA Consultation, paragraph 2.2, page 10.
[153] TalkTalk response to the September 2017 WLA Consultation, paragraph 4.21, page 20.
[154] UKCTA response to the September 2017 WLAC, paragraph 9, page 2.
[155] Openreach response dated 14 August 2017 to questions 1-4 of the 32nd s.135 notice.

cables services was related to labour costs. This was broadly consistent with the cost split that informed our initial estimates of costs in 2004. We said we would update our analysis using 2016/17 data for our final statement.

A12.66 We asked BT to provide 2016/17 data consistent with the restatement of Tie Cables costs within its 2016/17 RFS.[156] Whilst this still showed that roughly 70% of capex remained attributable to labour installation costs it also showed that in year labour installation capex attributed to tie cables was increasing and had increased significantly in 2016/17. We discussed this with BT who said the attribution of the costs from the relevant F8 codes costs to tie cables "did not solely reflect activity involved in installing Tie Cables and instead was driven by depreciation of other copper services, notably those in the E-side.[157] We therefore do not believe that the costs attributed from these F8 codes in 2016/17 provide a good estimate of the actual capex spend in 2016/17 on tie cables. Following further discussion with BT we decided to use an average of the costs BT provided from the years 2012/13 and 2014/15 as in this period the costs will be less distorted by historical depreciation data. Our base year adjustment makes two sets of changes to the costs of the main Tie Cables component, CL133. We have:

- Reduced the GRC, NRC and OCM depreciation for copper and local exchange capital costs by 70%;[158] and
- Added in £4.4m to pay operating costs for services SL128 and SL133.[159]

Table A12.9 Impact of Tie cable adjustment on the WLA market (£m)

	Opex Impact (£m)	MCE Impact (£m)
Tie cables adjustment	1.2	115.9

Source: Ofcom analysis of BT data

A12.67 Having made these base year adjustments, we have forecast tie cable costs until the end of the control period (with adjustments in the CPI-X model as set out in paragraphs A12.122 to A12.125 below), and calculated the charge controls that are set out in Annex 23.

Adjustment for co-mingling

Explanation of the adjustment

Our proposals

A12.68 Co-mingling services offer telecoms providers a Point of Presence (PoP) for compliant equipment at an MDF site. These services typically include the cost to BT of installing and

[156] Openreach response dated 28 November 2017 to questions 1-4 of the 32nd s.135 notice.
[157] Follow up call on 24 January relating to BT response dated 23 January 2018 to question 3 of the 46th s.135 notice.
[158] Costs in component CL133 are also attributed to service SL206. We have made our adjustment to all CL133 costs as we would expect a similar treatment of costs for all tie cable services.
[159] We have made this adjustment by increasing CL133 pay operating costs by c. £[✂]m to ensure that c. £[✂m is attributed to services SL128 and SL133. Some of CL133 costs are also attributed to SL206, Other Tie Cable services, which is not part of the charge controlled Tie Cables basket.

storing facilities for other telecoms providers to use when they provide LLU services. There are two main services: co-mingling new provides (SL131) and co-mingling rentals services (SL132).

A12.69 In the September consultation we set out three main issues that we noted as part of our review of costs for co-mingling services. These were:

- Some of the costs for co-mingling new provide services may have already been recovered: the services were charged for by one-off or up-front fees but the associated costs were also capitalised;
- We had overstated unit costs for co-mingling power and vent costs (component CL134) in the March consultation by not fully recognising that they are attributed across other services, notably SL207;[160] and
- Costs for co-mingling rentals in the base year may be too high as they may have been attributed too much of the costs for the class of work ACPA,[161] with too little having been attributed to GEA rental services.

A12.70 We therefore proposed to make certain adjustments to the base year by:

- removing historically incurred co-mingling survey and provision costs that had been capitalised but adding in estimates of the in-year expenditure, previously treated as capex, to operating costs, consistent with our approach on tie cables;
- uplifting component volumes for CL134 to reflect the use of this component by SL207; and
- reattributing ACPA costs from co-mingling services to GEA services.

Stakeholder comments

A12.71 Sky, TalkTalk and UKCTA responded to our proposals on these adjustments. All broadly agreed with the approach we had adopted. We have already addressed most of their comments when discussing our Tie Cables adjustment in paragraphs A12.51-A12.54 above.

A12.72 TalkTalk made one further point specific to co-mingling. It noted that we had attributed more APCA costs to GEA services, and that we had considered these costs were common and so had recovered them from both GEA and MPF charges. TalkTalk did not agree with this approach. It believed that none of the APCA cost that is not attributed to co-mingling is common to MPF and so all the non-co-mingling APCA cost should be recovered from GEA services.[162]

A12.73 BT made no comments on the adjustments we had proposed for co-mingling services.

Our analysis and decisions

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[160] See paragraphs 4.56-58 of the September consultation. SL207 is the service Other co-mingling and tie cable services.
[161] BT's response of 6 July 2017 to question 2(f) (1) and (ii) of the 27th s.135 WLA notice. ACPA costs cover "LLU related accommodation, cables and equipment; electronics, lights, power, network cables, security works, broadband enabled equipment and overheads (i.e. travel and subsistence, material handling charges, planning team salary costs)". BT's response of 18 August 2017 to question q2f (ii) of the 27th WLA 2017 s.135 notice.
[162] TalkTalk response to the September 2017 WLA Consultation, paragraph 4.18, page 19.

A12.74 In light of stakeholders' comments, which broadly agreed with the approach that we proposed, we have decided to adopt the main proposals that we made in the September consultation. However, we have decided to adopt a revised approach to the class of work (COW) ACPA costs based on information provided by BT.

A12.75 We therefore have made the following three adjustments to co-mingling services costs:

i) we have removed historically incurred co-mingling survey and provision costs that have been capitalised and added the in-year capex as pay and non-pay opex in the base year;

ii) re-attributed costs for the COW ACPA costs; and

iii) uplifted component volumes for CL134 to reflect the use of this component by SL207.

A12.76 The first two of these adjustments result in changes to costs in our base year, 2016/17. We describe how we have calculated these two adjustments in more detail below. We discuss how we have made the third adjustment in the CPI-X section of this annex, paragraph A12.124.

A12.77 With respect to adjustment (ii), we noted in the September consultation that we did not consider the information we had on ACPA to be reliable and that we therefore had to exercise our regulatory judgement using the cost information we had available. We said that we would be following up these data issues with BT.

A12.78 We have now been able to obtain the relevant information and have decided to use this to make our final adjustment. We believe that the final ACPA adjustment is more robust than the approach that we proposed for consultation since it is based on more reliable BT cost information gathered under our statutory powers and reduces the number of assumptions we need to make to carry out the calculation.[163] We explain the revised approach and data below.

A12.79 Lastly, in relation to TalkTalk's point, we do not necessarily classify any ACPA costs as being common costs and note that our adjustment is to FAC.

Calculation of the adjustments

A12.80 We have made the first adjustment in the same way as we proposed for the September consultation. We estimated the impact of the survey and provisioning costs that have historically been capitalised from the MCE and depreciation of the two components that contribute costs to co-mingling new provide services.[164] This adjustment reduces MCE by £90m and reduces depreciation by £9m.

[163] We note that if we had this information for the September consultation we would have used it.

[164] Information derived from Additional Financial Information (AFI) schedules. This is information provided by BT as part of the RFS.

A12.81 We estimated the in-year spend, which BT had treated as capex but which we now treat as opex, using data BT provided, broken down by capex to co-mingling services on the same two components by F8 code. This adjustment increases operating costs by £7.9m.[165] The size of this adjustment is similar to our estimate in the September consultation. The survey costs that are part of this adjustment are recorded under the ACPA COW.

A12.82 To make the adjustment on ACPA costs we used three sets of data. The first showed how GRCs, NRCs and Depreciation for the ACPA COW were attributed across plant groups, components and services within BT's 2016/17 RFS.[166] This then showed the underlying attributions of ACPA costs within our base year. As we said in the September consultation, we noted various issues with this attribution.

A12.83 The second data set showed how ACPA GBVs, NBVs and HCA depreciation costs split between the three asset policy codes that make up this COW.[167] This data was provided from BT's "Life of Plant" (LoP) list[168] data. This extracts data held on BT's fixed asset register, supplemented by further cost data for assets not yet registered, such as assets in the course of construction, from BT's general ledger. The total mean year GRC and NRC and in year deprecation in 2016/17 for ACPA from this LOP list data reconciled almost exactly with BT's RFS data from the first data set.

A12.84 In the third data set BT provided breakdowns that showed spend on each asset policy code over the last 6 years by programme.[169] This showed that spend on one of the asset policy codes (ALLU) was almost entirely related to co-mingling activity, whereas the great majority of spend on another asset policy code (AELP) was related to GEA services, including spend in BDUK areas. The spend on the third asset policy code was split between co-mingling, GEA services and various other services, including Ethernet private circuits.

A12.85 We have used this information to re-attribute the GRC, NRC and CCA depreciation costs for each policy code to services. This results in a revised attribution of ACPA GRC, NRC and CCA depreciation costs in the base year. The required adjustment is the difference between this revised attribution and that in the first data set. We have also ensured that this ACPA adjustment is consistent with the ACPA part of the first adjustment we make on survey costs. We note that the net impact of our final ACPA adjustment is different to that of our September adjustment.

A12.86 The revised attribution reflects differences in the average ages of co-mingling and GEA related ACPA assets, an issue we first highlighted in our March consultation.[170] Lastly the revised attribution reflects differences in asset lives. These are shorter for co-mingling assets than they are for GEA related assets. This was not reflected in BT's attribution in its

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[165] Openreach response dated 5 January 2018 to question 4 of the 44th s.135 notice.
[166] Openreach response data 30 January 2018 to question 10 of the 45th s.135 notice.
[167] As BT does not revalue its ACPA assets for CCA purposes GRC, NRC and CCA depreciation for ACPA are equal to GBC, NBV and HCA depreciation respectively.
[168] BT defines the LoP list as one of the data sources it uses. See page 314 of BT's 2017, AMD available at: https://www.btplc.com/Thegroup/RegulatoryandPublicaffairs/Financialstatements/2017/AMD2016-17.pdf
[169] Openreach response to question 19 of the 45th s.135 notice dated 26 January 2018.
[170] See March 2017 WLA Consultation, Volume 1, paragraphs 10.51-54.

RFS and hence in our base data nor did we reflect this in the adjustment we proposed in our September consultation.

Table A12.10 Impact of Comingling adjustment on the WLA market (£m)

	Opex Impact (£m)	MCE Impact (£m)
Comingling adjustment	2.6	102.8

Source: Ofcom analysis of BT data

A12.87 Having made these base year adjustments, we have forecast co-mingling costs until the end of the control period (with adjustments in the CPI-X model as set out in paragraphs A12.122 to A12.125 below), and calculated the charge controls that are set out in Annex 23.

Adjustments to the top-down cost forecasting

Introduction

A12.88 In this section we set out our decisions to make several adjustments to the forecast costs in the CPI-X model. Our discussion covers the following topics and in summary our decisions against each of these topics are:

- **Ongoing network adjustments** – we consider it appropriate to model the costs of an ongoing copper network, which requires an adjustment to BT's costs;
- **QoS adjusted usage factors** – in light of the expected changes to QoS, we consider it appropriate to adjust how shared repair costs are allocated across services;
- **Implementation of separately forecast costs** – we have separately forecast QoS repair costs, SLGs, cumulo, DPA costs, and sales of copper. We have incorporated these elements into the final forecasted costs in the CPI-X model; and
- **Adjusted approach for specific components and services** – we consider it appropriate to use a separate and simplified approach to forecast Openreach copper. We also adjust the co-mingling and tie-cable component cost forecasts. Finally, we set out our approach to forecasting TRCs and SFIs, which we have done separately from the CPI-X model.

A12.89 For each of these topics we discuss briefly our consultation proposals and where appropriate, stakeholder responses to these proposals. We then set out our reasoning and decisions for each topic in turn.

A12.90 We note that the structure and general forecasting equations in the top-down model are consistent with those set out in Annex 11. However, in some cases, we have carried out additional modelling to reflect various policy decisions, e.g. to encourage network investment and to improve quality of service.

Ongoing network adjustments

A12.91 As discussed in Volume 2, Section 2, we have decided to model the costs of an ongoing copper network. This is consistent with our approach to modelling an ongoing FTTC overlay network (discussed in Annex 14). In our consultations we proposed, and we have decided to make, the following two adjustments to reflect an ongoing copper network[171]:

- Steady state capex: this adjusts the base year capex to be equal to the base year OCM depreciation.
- Depreciation profile: this adjusts the cost recovery for components with heavily depreciated assets by adjusting both the asset lives (and thus the implied OCM depreciation) as well as the base year NRC (and therefore the return on capital employed).

A12.92 The steady state capex adjustment applies to all network components. In reality, capital expenditure can vary significantly year-on-year over the lifetime of an asset. In our modelling we consider it appropriate to smooth capex over time in order to ensure more stable prices. We note that an ongoing network would on average, over the lifetime of its assets, equate capex and disposals to OCM depreciation.

A12.93 In principle, we would expect an ongoing network to have assets with NRC to GRC ratios of around 0.5 to reflect the fact that it will replace heavily depreciated assets on an ongoing basis. However, given that, in the real world, the replacement of depreciated assets can fluctuate year-on-year (for instance in response to service volume changes) we expect that in any given year the observed ratio will be different to 0.5.

A12.94 Therefore, we consider it appropriate to only adjust Network Component Costs when the ratio is significantly different to 0.5. We consider the use of a 0.3 threshold to be conservative as it limits our cost uplifts for an ongoing network to network components that appear to have very depreciated assets.

A12.95 We found that ten WLA and WFAEL Network Component Costs have NRC to GRC ratios below 0.30, compared to the six that we proposed uplifting in our March consultation.[172] We have adjusted the base year NRCs for these Network Component Costs to be equal to 50% of their respective base year GRCs, and adjusted the asset lives based on our assessment of BT’s book lives. The ten Network Component Costs that we have adjusted are:

- MPF line testing systems;
- Local exchanges general frames equipment;
- Analogue line test equipment;

[171] Only Vodafone commented on our use of an ongoing network adjustment. Vodafone highlighted that the ongoing network adjustment results in excessive profitability but did not comment on the specifics of our approach. Therefore, we have summarised and addressed its comments in Section 2.
[172] We exclude from our assessment any components that are not forecasted in the top-down model (e.g. Time Related Charges and SLGs) or components that are not relevant for the WLA charge controlled products (e.g. Caller Display). We also exclude Openreach Sales Product Management and Pair Gain from our analysis but note that these components include very little capital costs.

- Analogue line cards;
- Co-mingling power & vent;
- Combi Card and MSAN Access – Voice;
- OR Service Centre – Provision Analogue/ISDN2;
- OR Service Centre – Provision WLA;
- OR Service Centre – Assurance Analogue/ISDN2; and
- OR Service Centre – Assurance WLA.

A12.96 We find that the steady state adjustment increases the 2020/21 forecast charge for MPF rentals by around £2 per line. The combined impact of our ongoing network adjustments is to increase the 2020/21 forecast charge for MPF rentals by around £8.60 per line.

QoS adjusted usage factors

A12.97 The top-down model forecasts costs based on network components which we then use to determine service costs. Usage factors allow us to:

- convert network component costs to service level costs and vice-versa; and
- convert service volumes to component volumes and vice-versa.

A12.98 As proposed in our March consultation, we consider it appropriate to reflect any changes in fault rates in the modelled usage factors.[173] This is consistent with the approach taken in the 2014 FAMR Statement.[174] Therefore, we made an adjustment to the usage factors for WLR, SMPF, and MPF rentals with respect to the four QoS related components that are shared across these services.

A12.99 In addition, in our September consultation, we proposed normalising the MPF usage factor to 1.14 and then adjust the WLR and SMPF usage factors accordingly.[175] This was to ensure that the QoS adjusted usage factors did not impact the total component volumes but simply reallocate costs across MPF, WLR, and SMPF. BT agreed with this approach, and no other stakeholders commented on this proposed approach.

A12.100 We continue to consider it appropriate to adjust usage factors as set out in the September consultation. The results and our full reasoning is set out in Annex 13.

Implementation of separately forecasted costs

QoS costs for repair and standards

A12.101 As set out above and in Annex 13, we have separately forecast repair costs taking into account the expected effect of Openreach's investment in network reliability (Fault

[173] Only Openreach commented on our March proposals for adjusting usage factors. We summarised and addressed its concerns in our September consultation.
[174] Ofcom, 2014 FAMR Statement, paragraph A13.60. https://www.ofcom.org.uk/__data/assets/pdf_file/0026/78812/annexes.pdf.
[175] We also corrected a modelling error by ensuring that the adjusted usage factors were being used to convert unit component cost forecasts to unit service cost forecasts.

Volume Reduction or FVR), the resource uplift needed to meet higher repair standards and our estimate of further efficiencies we expect it to achieve.

A12.102 We have incorporated our repair cost forecasts into the CPI-X model by including the forecast unit repair costs by component within the forecast unit LRICs, split by component. In the CPI-X model, we forecast the average MPF costs (i.e. weighted between SML1 and SML2). In order to determine the SML1 charge we have applied the service level differential (as set out in Annex 13) but weighted this differential by the proportion of LRIC+ that related to QoS repair costs.

SLGs

A12.103 As set out above and in Annex 13, we have separately forecast Openreach's Service Level Guarantee (SLG) payments, taking into account the effects of the QoS improvements and the industry scheme on retail automatic compensation. We have then incorporated the forecast SLGs by service into the CPI-X model.

A12.104 BT currently allocates the costs associated with SLG payments across both rentals and their associated ancillaries (i.e. connections and migrations). However, our forecast SLG payments are only split by technology (i.e. split by WLR, MPF, SMPF, and GEA but not rentals and connections). Furthermore, unlike our cumulo forecasts, the SLG payment forecasts are by service rather by component.

A12.105 Therefore, we need to consider an appropriate allocation rule for rentals and the associated ancillaries when implementing the forecast SLG payments into the top-down model.[176] We consider the usage factors for the Network Component "Service Level Guarantees" to be the best available information for allocating SLG payments across rentals and ancillaries. To allocate SLG payments across rentals and ancillaries for WLR and SMPF, we have used the relative usage factors across MPF rentals and ancillaries, for SLGs.

A12.106 We note that the relative payments to rentals and ancillaries may be different across WLR, SMPF, and MPF due to their different service level mixes. However, given that we have decided not to charge control WLR or SMPF, this allocation across WLR ancillaries is only for the purposes of the EPMU approach to common cost allocation.[177] We consider it unlikely that this modelling assumption will have a significant impact on our charge controls.[178]

Cumulo

A12.107 Cumulo rates are the non-domestic (business) rates that BT pays on the rateable assets (e.g. duct, fibre, copper, exchange buildings) within its UK network. BT's total non-domestic

[176] We continue to allocate the same total forecasted SLG payments to a given technology (e.g. MPF) as found in the SLG Forecast Model. We have simply implemented an allocation across rentals, connections, and migration services.
[177] The EPMU approach allocates common costs based on the relative LRICs of the copper and fibre rental services. Therefore, it is important to ensure we do not significantly over estimate the forecasted LRIC for WLR services.
[178] Furthermore, this is consistent with our modelling of SLGs where we assume similar incident rates and durations for rentals and ancillaries across WLR + SMPF and MPF.

rates bill will increase significantly over the charge control period due to the 2017 revaluation by the rating authorities.

A12.108 As noted in our discussion of base year adjustments above, we have excluded cumulo payments from the base year costs. We have separately forecast BT's cumulo bill and allocated it to WLA and WFAEL services, as set out in Annex 21.

A12.109 We use the cumulo forecasts as an input into the top-down model and they are calculated on a component basis. We consider cumulo to be part of the component LRIC and so have adjusted the forecast component LRICs (and FACs) within the top-down model. Specifically, we have removed the cumulo costs in the base year and then added in the forecast cumulo by component for each of the charge control years. This is then allocated to services using our calculated usage factors.

Costs and revenues associated with duct and pole access

A12.110 In our March and September consultations we proposed to include duct and pole access (DPA) related costs in the WLA charge control. Stakeholders did not respond to our September proposals to take account of these costs. Since our September consultation, we have updated our forecasts for DPA related costs based on updated forecasts and cost assumptions (see Section 5 of Volume 3 for details):

- **Network adjustment costs:** we have incorporated the proposed uplift to the regulatory cost base to reflect costs associated with the necessary adjustments undertaken to make Openreach's physical infrastructure ready for use. We have included an uplift of around £[✂]m over the charge control period.
- **Productisation costs:** we have updated the productisation costs in our analysis to reflect the latest proposals of around £[✂]m (around £8m) over the charge control period.
- **PIA rental revenue:** we have updated the expected recovery of costs from PIA rentals over the charge control period to around £[✂]m.

A12.111 Furthermore, we now consider it appropriate to spread these DPA related costs and revenues across WLR, MPF, and GEA rentals using the EPMU approach. This is because we consider it appropriate to treat these costs as common. The overall impact of including these DPA related cost adjustments is to increase MPF and GEA 40/10 rentals in 2020/21 by around £[✂] and £[✂] respectively.

Sales of copper

A12.112 As set out in Annex 22, we have determined the sales of copper that BT will be able to recoup when it moves to a FTTP only network. We have estimated the present value of the sale of copper proceeds to be £240m and consider it appropriate to spread the recovery of the future value from sales of copper over the next 12 years.

A12.113 We note that the revenue earned from future copper sales is due to the residual value of assets found in the copper network. We consider it likely that the future value from the sales of copper will primarily be incremental[179] and note that the incremental current value of the copper asset is allocated entirely to copper lines in our model. Therefore, we consider it appropriate to spread this revenue over all copper lines.

A12.114 In summary, we have implemented the sales of copper adjustment within the top-down model by:

- calculating the present value of the proceeds in 2030 based on the estimated future proceeds[180] using a discount rate of BT's cost of capital;
- converting the calculated present value into a constant real terms annual adjustment; and
- attributing this adjustment across all copper access lines (i.e. WLR and MPF) adjusting for inflation over time.

A12.115 We find that including the sales of copper within the top-down model, as set out above, results in the cost of MPF Rentals in 2020/21 reducing by around £0.70 per annum.

Adjustment approach for specific components and services

OSS/BSS costs

A12.116 As set out in Annex 14, we have included incremental OSS/BSS spend in the bottom-up model as part of our calculation of the GEA LRIC. We have found that some of the costs that we have allocated to GEA services are currently allocated to copper services in BT's 2016/17 RFS, and hence will be included in our forecasts of WLR and MPF costs in the CPI-X model. In order to avoid double recovery of these costs, we have removed [✂] of the incremental OSS/BSS allocated to WLR and MPF rentals in the CPI-X model.

Openreach copper

A12.117 We are unable to use the methodology set out in Annex 11 to calculate the cost of the Network Component Cost "Openreach Copper". This is because BT has provided costs by service within our base year data but is unable to provide network component volumes.

A12.118 We found that the Openreach Copper Component is entirely made up of the Notional Debtor cost category and is therefore an entirely NCA related cost. Furthermore, the component LRIC to FAC ratio is 1, which suggests that all costs allocated to this component are incremental.

A12.119 In the 2016 BCMR Statement, we estimated forecasts for a component with similar characteristics (Openreach Non Copper, an administrative cost) in line with service

[179] We recognise that some of the sales of copper value could be considered as common. However, we expect this windfall to be obtained when PSTN and standard broadband services are no longer provided. Therefore, we consider it consistent to treat this value as incremental to those services.

[180] This is calculated using our estimate of the net proceeds from the sale of E-side copper (i.e. £240m) and inflating this by RPI (i.e. the index used for copper price inflation in our cost forecasts).

volumes.[181] We also proposed this approach in our March consultation and no stakeholders commented.

A12.120 We continue to consider it appropriate to apply a simplified approach given the relative magnitude of these costs. However, we also consider it appropriate to try to maintain the current allocation of Openreach Copper costs across WLA and WFAEL services as long as this can be done in a simplified way.

A12.121 We have adjusted the component volume for Openreach Copper to one rather than zero as this avoids an error term in the model and allows us to calculate usage factors.[182] We note that this impacts the allocation of Openreach Copper component costs but not the forecasted unit cost for this component.

Co-mingling and tie cables

A12.122 In our September consultation, we proposed uplifting the forecast WLA tie cable and Co-mingling power and vent component volumes. This was to account for the fact that the base year costs included costs for services that we did not propose charge controlling.[183] Openreach[184] argued that this adjustment was double-counted there was therefore is a risk of under-recovery.

A12.123 We disagree with Openreach. We note that our adjustment results in total component volumes for WLA tie cables in 2016/17 that equal the total component volumes provided by BT provided. Therefore, we have decided to uplift the calculated 2016/17 component volumes in the CPI-X model for WLA tie cables and Co-mingling power and vent so that they reconcile to the BT's regulated accounts.

A12.124 For Co-mingling power and vent, we apply the same uplift for all forecast years. This is because we expect SL207 (co-mingling services that are not charge controlled) to broadly follow the same volume trend as SL132 (the charge controlled service which we forecast service volumes for).

A12.125 For WLA tie cables, we calculate the uplift in forecast years based on the ratio of total LLU rental volumes to internal LLU rental volumes (as found in the WLA Volumes Module). This is because standard tie cable services are used both internally by BT downstream and externally by other telecoms providers. Other tie cable services, on the other hand, are only internally used, thus we consider it likely that these volumes will follow the trend in internal LLU rentals.

TRCs and SFIs

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[181] Ofcom, 2016 BCMR Statement, 22 March 2016, paragraph A26.52.

[182] We note that the component volume for Openreach Copper in the CPI-X model is less than one. This is due to Openreach Copper being allocated to services that are not charge controlled (e.g. Other tie-cable and co-mingling services) or whose costs are forecasted outside of the CPI-X model (e.g. TRCs and SFIs).

[183] These services were 'Other co-mingling and tie cables', or SL206 and SL207 as found in BT's AMD.

[184] See Openreach response to the September 2017 WLA Consultation, paragraphs 117-19.

A12.126 As set out in Annex 23, we consider that price regulation for Time Related Charge (TRCs) and Special Fault Investigation (SFI) services is necessary as the services are not contestable. Furthermore, consistent with the 2014 FAMR Statement,[185] we consider that the charges for SFIs should be aligned with the underlying hourly TRC cost estimates. Therefore, we have applied the same cost trend to both TRCs and SFIs.

A12.127 In order to set a charge control, it is necessary for us to decide on appropriate unit costs based on the available information. We note that, in response to our March consultation, Openreach[186] argued that our forecast costs for TRCs were understated. Our costs were based on the 2015/16 RFS which was the most recent published RFS at the time. As with our base year costs, we had intended to update this to 2016/17 when this RFS was available (as we consider it appropriate to use the most recent cost information available). As set out below, we consider that the use of the 2016/17 costs addresses the concerns that Openreach has raised.

A12.128 We have calculated the charge control for these services based on 2016/17 costs and revenues and an estimated cost trend. We note that the charge for these services is based on an hourly cost so the general top-down approach of using volume forecasts and AVEs/CVEs is not appropriate.

A12.129 In considering revenues and costs for TRCs, we acknowledge that TRCs are provided across BT's portfolio of products and not just for LLU or WLR services (e.g. they are also provided for Ethernet). However, TRCs do not significantly differ depending on whether they are bought for WLR, LLU, or Ethernet services. Therefore, for the purposes of forecasting cost trends for TRCs and SFIs, we have considered the aggregate data across all WLA and WFAEL TRCs.[187]

A12.130 We have found that the total FAC for TRCs and SFIs significantly increased in 2016/17 (compared to 2015/16) due to an increase in service volumes. [✂[188]].[189]

A12.131 For SFIs, we have found that in 2016/17 costs increased to £47.9m yet revenues increased by a significantly lower rate, even though both costs and revenues are both primarily driven by changes in line volumes. We found that this is because in some cases a customer is not billed for an SFI, but BT nonetheless incurs the cost associated with sending an engineer to investigate the customer issue.[190]

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[185] Ofcom, 2014 FAMR Statement, Volume 1, paragraph 18.168.

[186] Openreach response to the March 2017 WLA Consultation - Volume 2, paragraphs 135-138.

[187] While we use the data for all TRCs for our analysis (given we would not expect costs or prices to vary significantly according to the wholesale product they are provided for), we note that here we are only imposing a charge control for those TRCs that relate to MPF and GEA services.

[188] [✂].

[189] Openreach response dated 16 February 2018 to Question 1 of the 49th s.135 notice.

[190] SFIs are charged where there is no 'hard' fault on the Openreach network. Therefore, SFIs may not be charged when the remote test fails to find a network fault (thus an SFI is ordered) but the SFI engineer finds a network fault when they undertake a more sensitive test at the customer premises. Alternatively, an SFI may not be charged when the Openreach assurance team remove any charges assessed as invalid.

A12.132 We consider it appropriate to allow the recovery of efficiently incurred costs when an SFI is ordered but not billed because Openreach will incur costs regardless. However, we consider it appropriate to recover these costs via MPF rentals rather than via the SFI service as it is likely that these costs would have otherwise been incurred due to routine maintenance of MPF lines.[191] Therefore, we have reallocated around £8.7m costs from SFIs to MPF rentals.

A12.133 We also consider that some of the increase in costs in 2016/17 was due to inefficiency. This is because a greater proportion of SFI orders were rejected for billing in 2016/17 compared to 2015/16. Openreach was unable to identify any obvious reason for why there was a large increase in 2016/17.[192] We consider it unlikely that Openreach's ability to remotely find a fault has significantly changed from 2015/16 to 2016/17.

A12.134 Therefore, we consider it appropriate to assume that BT could have achieved the 2015/16 rejection rate in 2016/17 and therefore the additional engineer costs associated with the higher rejection rate in 2016/17 was inefficient. We have excluded the associated costs of around £2.7m from our charge controls.

A12.135 We have applied the same forecasting methodology as in the 2016 BCMR Statement[193] but using our own forecast price inflation for pay costs and opex efficiency (see Annex 17 for details). This results in an estimated cost trend of around -0.7% per annum. We have applied this cost trend to the adjusted 2016/17 costs of [✂]m and £36.6m, for TRCs and SFIs respectively.

A12.136 We then calculated the charge control X values using the adjusted glidepath approach set out in Annex 11, leading to the following results:

Table A12.11: Adjusted X values for TRCs and SFIs

	2018/19	2019/20	2020/21
TRCs	-20.1%	-11.9%	-2.7%
SFIs	-6.3%	-4.6%	-2.7%
Weighted average	-15.0%	-9.2%	-2.7%

Source: 2016/17 AFI with Ofcom forecast and adjustments based on Openreach's response to the 44th s.135 notice

A12.137 We consider it appropriate to apply the same weighted average X to both TRCs and SFIs. This is because we expect the costs of these services to be broadly similar, given the use of similar activities, and so we consider it appropriate to align the charges. Furthermore, we

[191] We note that SFIs are primarily ordered for MPF lines so when an SFI is ordered but not billed it is likely that this is associated with faults on an MPF line.
[192] Openreach response dated 9 January 2018 to Question 6c of the 44th s.135 notice.
[193] 2016 BCMR Statement, paragraph 8.99.

consider this to be consistent with the 2014 FAMR Statement, where we aligned charges across these services.

A13. Quality of service cost modelling

A13.1 In the 2018 QoS Statement we set out our review of the quality of service (QoS) of Openreach's voice and broadband services in the WLA and WFAEL markets. We have set a package of requirements on BT that are aimed at delivering more reliable and predictable experiences for consumers. These include standards that require Openreach to repair more network faults on time and our forecast of a reduction in Openreach's network faults over the review period.

A13.2 This Annex sets out how we have taken into account the impact of the QoS improvements on forecast costs in our charge control modelling. In summary, first we calculate repair costs in the base year based on information gathered from Openreach We then forecast the repair costs taking into account the expected effect of Openreach's investment in network reliability (Fault Volume Reduction or FVR), the resource uplift needed to meet higher repair standards and our estimate of further efficiencies we expect it to achieve. Second, we forecast Openreach's Service Level Guarantee (SLG) payments, taking into account the effects of the QoS improvements and the voluntary agreement on retail automatic compensation.[194]

A13.3 Below we set out our analysis relating to each of these steps, detailing our proposals in the March and September consultations, stakeholder responses and any further analysis we have taken into account.

Repair costs

Our proposals

A13.4 In our charge control modelling for the March consultation, we proposed individual adjustments to account for the effects on Openreach's costs of FVR and QoS standards. We made these adjustments in the CPI-X model by applying the effects of FVR and QoS standards to the proportion of operating costs we estimated to be repair-related. In addition, as part of our forecasting of these costs, we applied our proposed overall operating cost efficiency assumption.

A13.5 To determine the level of the QoS adjustments required, we modelled a linear relationship between the fault rate and repair costs and assumed a decrease in the fault rate of c.[✂][195] (18-21%) by the end of the control.[196] We also estimated that our proposed QoS standards

[194] Ofcom, 2017. *Automatic Compensation – Statement.* https://www.ofcom.org.uk/consultations-and-statements/category-1/automatic-compensation.

[195] We assumed c.[✂] (18%-21%) reduction in the fault rate in our March consultation which was equivalent to a c.[✂] (22%-25%) reduction in fault volumes. As set out in the 2018 QoS Statement, Annex 2, the fault rate reduction is less than the fault volume reduction due to the growth in high speed broadband services, which have relatively high fault rates. In this annex, we refer to changes in fault rates as these are the relevant inputs for our repair cost modelling. Line volume growth is taken into account separately in our cost modelling.

[196] Ofcom analysis of BT data submitted in response to the 6th FAMR QoS notice of 3 March 2014 and the 2nd QoS notice to BT of 25 May 2016.

would increase repair costs by around 8% (compared to the base year). Overall, we estimated the FVR reduction and increase in QoS standards would result in a decrease in MPF and GEA 40/10 rental costs of £1.59 and £0.18 per annum respectively (compared to a counterfactual of no QoS adjustments).

A13.6 We used the same methodology in the September consultation but updated our proposals on the level of FVR savings and QoS standard uplifts to reflect our analysis of responses and further evidence gathered as part of our review of Openreach's QoS:

- A lower reduction in the fault rate (c.[✂][197] (10-13%) over the forecast period). This reflected our updated forecasts of faults.[198]
- A larger QoS standards uplift (c.11% over the forecast period). This took into account additional evidence from Openreach on the level of repair performance that was operationally feasible, and the additional resources needed to meet higher performance standards.

A13.7 These updates resulted in an overall decrease in MPF rental costs of £0.76 and an increase in GEA 40/10 rental costs of £0.17 (compared to a counterfactual of no QoS adjustments).

A13.8 In the September consultation, we also proposed making an adjustment to BT's usage factors to account for the relative fault rates of the different services (MPF, WLR and SMPF), as well as the expected change in service level mixes. We proposed modifying the approach used in the March consultation to ensure that while we were changing the relative usage of shared repair-related components by the different services[199], the overall level of the forecast cost stack would not be changed in the base year.

A13.9 In addition, we proposed in the September consultation that our approach to forecasting capital expenditure (capex) on the basis of an ongoing network with a steady state adjustment would provide sufficient capital costs over the course of the control period to fund Openreach's planned investment in FVR. In terms of operating expenditure (opex), we uplifted 2015/16 costs by [✂] to reflect the higher amount of opex that we expected Openreach to spend on FVR activities going forward.

Stakeholder responses

A13.10 Openreach was concerned that our 'building-block' approach to incorporating FVR and efficiency in our cost forecasts risked counting the same cost savings more than once.[200] It argued that to avoid double-counting savings due to FVR, we should factor in the reduction of costs relating to FVR in the forecast years but remove this impact from the base level of

[197] We assumed c.[✂] (10%-13%) reduction in the fault rate in the March consultation which was equivalent to a c.[✂] (15%-18%) reduction in fault volumes.

[198] Ofcom analysis of Openreach data submitted in response to the 6th FAMR QoS notice of 3 March 2014, the 2nd QoS notice to BT of 25 May 2016 and the 7th QoS notice to BT of 5 June 2017.

[199] These costs are found within the following four network cost components: D side copper current, E side copper current, Local exchanges general frames maintenance and Analogue line drop maintenance.

[200] Openreach response to the March 2017 WLA Consultation- Volume 2, paragraphs 285-93.

efficiency being assumed.[201] Openreach also argued that our assumptions on the potential for cost savings are far greater than the costs savings that its Service Delivery organisation has achieved so far, and are significantly higher than Openreach's aspirational plans going forward given the activities required to meet increased QoS standards and reducing trends in productivity.[202]

A13.11 TalkTalk disagreed with Openreach that the efficiency and FVR assumptions double-count the potential savings. TalkTalk stated that because BT's 6.6% historical efficiency was achieved without making fault reductions it is reasonable to achieve both the fault reduction (of about 10%) and the efficiency gains (5.5% on opex and 3% on capex).[203]

A13.12 Openreach agreed with the principle of reducing repair costs to take into account FVR over the control period. While it also agreed with assuming a linear relationship between direct costs and fault rates, it did not believe this to be the case for indirect costs (direct and indirect costs are explained below) because it considered they were less scalable with repair volumes[204] and that there would be a need to recruit and train more people to meet the higher service levels.[205] Openreach also argued that it was not appropriate to assume that the proportional reduction to repair costs due to FVR could be applied to a base which includes the additional costs associated with servicing these faults. Instead, it believed the QoS uplift and FVR adjustment should be modelled in an additive way (rather than a multiplicative way).[206] In addition, it argued that our approach of applying the QoS uplift to the repair costs after the fault rate reduction had been implemented was a mathematical error that would unnecessarily dampen the desired impact of the adjustment.[207]

A13.13 Sky said that Openreach should not be allowed to recover any costs of improved service quality through regulated charges as this did not reflect normal commercial practice, noting it was typical for service improvements to come at no (or less) cost.[208]

A13.14 Openreach agreed with our revised approach to adjusting usage factors for repair components outlined in the September consultation.[209] It also agreed that our proposed modelling approach would provide sufficient capex and opex needed for its planned FVR investments.[210]

A13.15 TalkTalk considered that 100% of FVR expenditure should be capitalised since the beneficiaries of the expenditure are the users of the network over many years into the future.[211] Vodafone argued that the increase in opex for FVR expenditure should be offset

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[201] Openreach response to the September 2017 WLA Consultation, paragraphs 81-83.
[202] Openreach response to March 2017 WLA Consultation- Volume 2, paragraphs 294-304.
[203] TalkTalk response to the September 2017 WLA Consultation, paragraphs 2.12-14.
[204] Openreach submission to Ofcom on 27 November 2017, [✂].
[205] Openreach response to the September 2017 WLA Consultation, paragraphs 71-76.
[206] Openreach response to the September 2017 WLA Consultation, paragraphs 77-78.
[207] Openreach response to the September 2017 WLA Consultation, paragraph 89.
[208] Sky response to the September 2017 WLA Consultation, paragraph 6.12.
[209] Openreach response to the September 2017 WLA Consultation, paragraphs 93-94.
[210] Openreach response to the September 2017 WLA Consultation, paragraphs 79-80.
[211] TalkTalk response to the September 2017 WLA Consultation, paragraph 2.15.

by a corresponding reduction in capex.[212] In addition, TalkTalk disagreed with Openreach that FVR costs before March 2017 should be included in the upcoming charge control. It argued that such an approach would be retrospection and would be particularly inappropriate given Openreach's profitability over the last 10 years.[213]

Our reasoning and decisions

A13.16 In this subsection, we set out our reasoning and decisions on the main issues raised in stakeholders' responses. The subsection is structured as follows:

- First, we detail our approach to calculating repair costs in the base year (2016/17). In summary, we have used BT information gathered under our formal powers and our own assumptions to calculate total repair costs for copper services of c.£364m in 2016/17.
- Second, we discuss our modelling approach to forecasting repair costs for copper services. In summary, we have forecast repair opex separately from non-repair opex to improve the transparency of our modelling and to avoid double counting the cost savings captured through our QoS and efficiency assumptions.
- Third, we detail the modelling assumptions used to forecast repair costs. In summary, we have refined our assumptions on the FVR reduction and QoS uplift and have taken account of the further savings for repair costs we expect Openreach to achieve (e.g. due to task time efficiency).

Calculating base year repair costs

A13.17 Using our formal powers, we gathered information from Openreach regarding the direct and indirect costs associated with the repair of copper services within the WLA and WFAEL markets. According to BT, direct costs are costs that are directly allocated to classes of work (COW) due to repairs, such as the pay costs of engineers carrying out reactive repair work. Indirect costs are any other costs that BT believes are incurred as a result of repair and include costs for training and management time.

A13.18 We then analysed the cost information BT provided to determine the costs we consider are most relevant to the repairs of WLA and WFAEL services. For the purposes of our modelling, we have defined direct repair costs as the costs BT has attributed to the Maintenance cost sector in Openreach's Service Delivery division.[214] We have defined indirect repair costs, which span a number of cost sectors[215], as the indirect costs BT has attributed to Service Delivery.

[212] Vodafone response to the September 2017 WLA Consultation, Section 1.3.
[213] TalkTalk response to the September 2017 WLA Consultation, paragraph 2.16.
[214] Service Delivery costs are held within the Organisation Unit Code (OUC) BV and Maintenance costs are held within REFINE sector B2.
[215] For example, the cost sectors containing Service Delivery indirect costs include Supplies, Plant Support and Personnel and Admin.

A13.19 We did not include other indirect costs identified by BT which are attributed to other Openreach divisions.[216] We consider these other indirect costs are likely to be less closely related to Openreach's repair activities. In addition, BT explained that the indirect costs it provided covered both repair and provision activities and that it was not able to provide a more granular breakdown.[217] To split the indirect costs between repair and provisions, we therefore used the mapping of components to services given by the usage factors and assumed that all costs attributed to rental services were repair-related (and hence all costs attributed to connection services were provision-related).

A13.20 Having determined repair costs using this approach, we noted that the relevant costs in 2016/17 were higher than in 2015/16. In response to our follow up questions to understand the causes of the difference, BT explained:

- Inclusion of transport costs ([✂]): the relevant costs for 2016/17 were higher than in 2015/16 partly due to BT erroneously excluding transport costs from the data provided for 2015/16. Further to this, we included costs for 'Non-pay other supplies' that includes the costs of leasing vehicles and parts for those vehicles.
- Increase in pay costs ([✂]): There was also an increase in the 'General Management and Other' costs due to a reclassification of capitalisation credits[218] as well as a reorganisation moving costs from other organisational unit codes (OUCs) into service delivery.[219]

A13.21 Table A13.1 below sets out our estimates of repair costs for 2016/17 which we have used in our cost modelling. For the purposes of comparison, it also shows repair costs for 2015/16.

Table A13.1 Total Direct and Indirect repair related costs[220]

	2015/16	2016/17
Direct and indirect costs	£296m	£364m

Source: BT

Modelling approach to forecasting repair costs

A13.22 Having calculated base year repair costs, we then forecast these costs to the end of the charge control period. In this subsection, we set out our forecasting approach.

A13.23 In reaching a conclusion on our modelling approach, we have considered Openreach's concerns around the risk of double-counting the FVR impact on copper services in the charge control, through both the fault volume assumptions and the efficiency assumptions. In the March consultation where we proposed an opex efficiency assumption of 5.5%, we

[216] For example, Openreach CIO, BW Service Management and BJ Legal, Risk and Equivalence.
[217] Openreach's response dated 6 November 2017 to clarification question 2 in relation to question 10 of the 34th s.135 notice.
[218] This methodology change was discussed within Annex 11 of the March 2017 WLA Consultation.
[219] Openreach's response dated 6 November 2017 to a clarification of question 10 of the 34th s.135 notice.
[220] Openreach's response dated 27 September 2017 and 31 January 2018 to question 10 of the 34th s.135 notice.

noted that during the historical period used in our assessment Openreach's fault rate was relatively flat.[221] As TalkTalk pointed out, this implied that if Openreach had lower faults during this period its historical cost savings would have been higher. Were this the only relevant information source it may be reasonable to assume Openreach could make FVR cost reductions as well as efficiency cost reductions, and therefore we could model them as two separate adjustments.

A13.24 However, as set out in Annex 19, we have also used other sources of information, such as BT's forecast accounting information, to arrive at our efficiency assumption. These information sources span total operating costs and cover all means of cost savings, including the savings that might be achieved by doing things less often (e.g. through reduced fault visits), by doing them more quickly and stopping doing things that are no longer needed. In principle, it would be possible to derive an appropriate level of cost saving by combining adjustments for the expected market-level efficiency trends and adjustments to repair opex due to QoS improvements (i.e. our consultation approach). However, we accept that there is a risk of overlap between these two adjustments and that it is difficult to uncouple QoS-driven savings from other cost savings within the forecast information being used in our efficiency analysis.

A13.25 Therefore, to increase transparency and mitigate the risk of double-counting cost savings, we have changed our approach. In particular, for copper services we have modelled repair opex separately from non-repair opex. We have forecast non-repair costs in the CPI-X model using the standard opex forecasting formula with the key difference that the efficiency assumption is based on our assessment of the cost trends specifically for non-repair opex in BT's historical and forecast cost information:

> Non-repair opex(t) = Non-repair opex(t-1) * [1 – non-repair efficiency] * [1 + Input price changes(t)] * [1 + %volume change(t) * CVE]

A13.26 Annex 19 sets out how we have identified repair opex in BT's historical and forecast accounting data to carry out our efficiency assessment for non-repair costs only.

A13.27 For repair opex, as with SLGs and cumulo, we have forecast costs in a separate model reflecting the unique cost trends they are likely to be subject to over the charge control period. In particular, because repair opex mainly consists of the costs of deploying engineers to reactively repair faults on the Openreach network, in the main, changes in costs will be driven by the targets on the level of faults on the network and the responsiveness of engineers to faults (as set out in our 2018 QoS Statement). Therefore, instead of applying the overall opex efficiency assumption to repair opex, we have captured changes in costs by separately applying adjustments for the FVR reduction and the QoS standards uplift, and by including an assumption on further efficiencies. This is carried out in our repair cost model where we forecast copper service costs using the following steps:

[221] March 2017 WLA Consultation, paragraph A15.101.

a) Forecast repair opex absent cost savings: We forecast repair opex by component until the end of the control period using the following formula:

Repair opex(t) = Repair opex(t-1) * [1 + Input price changes(t)] * [1 + %volume change(t) * CVE].

Note that this first step does not include an efficiency assumption or any QoS-related assumptions.

b) Apply expected fault reduction rate to reduce forecast repair costs: We calculate the proportional change in fault rates compared to the base year (2016/17) and apply these to the forecast repair opex calculated in step (a). Consistent with the March consultation, we have assumed that there is a linear relationship between the fault rate and repair costs.

c) Apply QoS standards uplift to increase forecast repair costs: We have calculated the proportional increase in resources that will be required so that Openreach can meet the higher repair standards set out in the 2018 QoS Statement and apply these to the adjusted forecast repair opex calculated in step (b). This also assumes a linear relationship between the QoS standards uplift and repair costs.

d) Apply further efficiencies assumption: We have estimated the additional savings in repair costs Openreach can achieve that are not related to fault reduction (e.g. due to task time or technological improvements) and apply these to the adjusted forecast repair opex calculated in step (c). Again, we assume a linear relationship.

e) Convert forecast repair costs to service costs: We first convert costs by component into costs by service by applying usage factors to the forecast repair opex by component, calculated in step (d). We do this using QoS-adjusted usage factors, which are BT's usage factors adjusted to account for the relative fault rates of the different services (MPF, WLR and SMPF), as well as the expected service level mix during the control period. This gives us repair opex for services across all Service Maintenance Levels (also referred to as SMLs or care levels). As the different SMLs require different proportional increases in resources and it is MPF SML1 we are charge controlling, we have then disaggregated MPF repair costs into SML1[222] and SML2[223].

A13.28 Although we have modified our approach by modelling repair opex separately, we have maintained our methodology of first multiplying repair opex by the FVR adjustment factor (step (b)) and second multiplying the FVR-adjusted repair costs by the QoS standards uplift (step (c)). Contrary to Openreach's view, this 'multiplicative' approach is an appropriate way of taking into account the effect of QoS improvements on repair opex. The QoS standards uplift has been estimated on the basis of the Ofcom Resource Performance Model (RPM) and Openreach's Allocation model, and represents the proportional increase in engineer resource we have forecast Openreach will need to ensure that it meets the higher repair standards over the control period. It does not represent the absolute increase

[222] SML1: Fault clear by 23:59 day after next, Monday to Friday, excluding public and bank holidays.
[223] SML2: Fault clear by 23:59 next day, Monday to Saturday, excluding public and bank holidays.

in resource needed, either in terms of money or the number of engineers. Our approach first takes into account the reduction in resources dedicated to WLA and WFAEL services Openreach should be able to achieve given its expected lower fault volumes. Any increases needed to meet the repair standards would be relative to this scaled-down pool of resources.

A13.29 We have also considered Openreach's view that certain indirect repair costs would not have a linear relationship with the level of faults. We maintain that assuming linearity for these costs is a reasonable modelling simplification:

- First, the type of indirect costs Openreach has highlighted relate to the 'non-productive' tasks associated with its engineer workforce, such as training, end of day travel and one-to-one meetings.[224] The scale of the fault reduction being forecast for copper services ([✂] (10-13%) over the four year forecast period)[225] discussed below is significant enough to result in a reduction in the engineer headcount working on WLA and WFAEL services and this, in turn, would translate into a reduction in such indirect costs. For example, fewer engineers would result in the time spent on tasks such as training and management either reducing or being dedicated to non-repair activities or other services.
- Second, to the extent that these indirect costs are less scalable to fault volumes (compared to direct costs), any non-linearity between forecast fault rates and costs would be mirrored in the relationship between forecast QoS standards and costs. Therefore, since the two effects are working in opposite directions and are of a similar magnitude (see Tables A13.2 and A13.6 below), the net impact of assuming a linear relationship for indirect costs is likely to be relatively small (compared to a non-linear relationship).

A13.30 Lastly, we have considered Openreach's concerns about applying the QoS standards uplift to repair costs as a proportion of total opex after the FVR adjustment in the CPI-X models published alongside the consultations. We agree that this was not appropriate because the FVR adjustment was also applied in the CPI-X models, meaning this would have resulted in the QoS standards uplift being applied to too small a pool of costs. As set out above, for the statement we have modified our approach whereby repair opex is now entirely forecast in a separate model. This simplification to our approach means that there is no longer a need to calculate repair costs as a proportion of total opex when applying the QoS adjustments and as a result this issue no longer arises.

Modelling assumptions

A13.31 In this subsection, we detail the individual assumptions we have used to forecast repair costs and set out the impact of each on forecast costs (steps (b) to (e) above). First, we set out our forecast of fault rates during the control period. Second, we discuss how we have captured the funding for the planned FVR investment through the capex and opex forecast

[224] Openreach response to the September 2017 Consultation, paragraphs 71-76.
[225] See 2018 QoS Statement, Annex 1 for details on the derivation of our fault rate forecast.

in the charge control. Third, we set out our assumptions on the resource uplift needed to meet the higher repair standards. Fourth, we detail our assumptions on the further efficiencies we expect Openreach to achieve. Fifth, we set out our assumptions on QoS usage factors and service level differentials.

Fault reduction assumptions (step (b))

A13.32 We expect Openreach to reduce the rate of faults over the forecast period and that this will lead to savings in repair costs. [226]

A13.33 As set out in Annex 1 of the 2018 QoS Statement, we have considered in detail the fault rates for WLR and WLA services for the purpose of setting the charge control. We have developed a forecast by identifying the fault rates in the base year (2016/17) and taking into account the effects of Openreach's preventative FVR programme and underlying trends in technology until the end of the control period (2020/21). Across all services, we forecast an overall reduction in fault rates of [✂] (10-13%) over the four year forecast period (which equates to [✂] (2-3%)) per annum). Table A13.2 below sets out our forecast of fault rates for each service during the charge control period.

Table A13.2: Forecast fault rates for copper and GEA FTTC services

Charge control period	Base Year 2016/17	Year 1 2018/19	Year 2 2019/20	Year 3 2020/21
WLR	8.0%	[✂]% (7-8%)	[✂]% (7-8%)	[✂]% (6-7%)
MPF	11.1%	[✂]% (10-11%)	[✂]% (9-10%)	[✂]% (9-10%)
WLR+SMPF	12.4%	[✂]% (11-12%)	[✂]% (10-11%)	[✂]% (10-11%)
WLR+GEA-FTTC	14.1%	[✂]% (12-13%)	[✂]% (11-12%)	[✂]% (11-12%)
MPF+GEA-FTTC	15.1%	[✂]% (13-14%)	[✂]% (12-13%)	[✂]% (11-12%)

Source: Ofcom analysis of BT data[227]

A13.34 We have maintained our approach of assuming a linear relationship between fault rates and repair costs. As shown in Table A13.3 below, we have calculated that the impact of the reduction in faults from the base year to the end of the control will be to reduce the 2020/21 annual rental unit costs by £2.59 for MPF and £0.53 for GEA 40/10. We note that these impacts are larger than those calculated for the September consultation despite the FVR adjustment being of a similar magnitude. This is because the pool of repair costs that we have applied the adjustment to is now larger. As set out above, we have calculated higher repair costs in the base year (2016/17), and have calculated the impact before applying an efficiency assumption to forecast costs.

[226] The annual fault rate = Fault volumes in given year / rental volumes in given year.
[227] Data submitted in response to the 6th FAMR QoS s.135 notice of 3 March 2014, the 2nd QoS s.135 notice to BT of 25 May 2016, the 7th QoS s.135 notice to BT of 5 June 2017, the 9th QoS s.135 notice to BT of 29 June 2017 and the 34th s.135 notice to BT of 16 August 2017

Table A13.3: Impact of forecast fault rate reduction on unit costs (£ nominal, annual)

	2018/19	2019/20	2020/21
MPF rental unit cost	-1.48	-2.10	-2.59
GEA 40/10 rental unit cost	-0.37	-0.48	-0.53

Source: Ofcom modelling

Funding of fault reduction programme

A13.35 To implement its planned FVR programme, Openreach must spend additional preventative maintenance capex and opex over the course of the forecasting period. We have therefore considered whether our cost forecasts provide sufficient allowance for this additional expenditure.

A13.36 As set out in Annex 11, we have adopted a modelling approach of forecasting capex on the basis of an ongoing network with a steady state adjustment. The ongoing network adjustment increases the value (NRC[228]) of some heavily depreciated assets and the steady state adjustment equates base year capex with base year OCM depreciation.[229] Capex for subsequent years is then forecast by applying efficiency and price change assumptions to the steady state capex and adding (or subtracting) any additional capex to meet increased (or decreased) demand.

A13.37 We have assessed whether our capex modelling approach will allow Openreach to recover the costs of the planned FVR programme by comparing our forecast of capex for WLR and MPF services with Openreach's historical level of capex. We have found that Openreach's planned FVR investment of [✂] over 5 years (c.[✂] a year) would be fully funded by the capex uplift that we proposed to allow in the charge control.[230] This is illustrated by Figure A13.4 below which shows that the annual capex for WLR and MPF services forecast for the charge control would allow recovery of Openreach's level of actual capex in 2016/17, which includes the increase in Openreach's capex due to the investment in FVR.

Figure A13.4: [✂[231,232]]

Source: 2017 WLA charge control model and Openreach response to question 1 of the 7th QoS s.135 notice of 5 June 2017

A13.38 In response to the March consultation, Openreach explained that its total FVR spend of c.[✂] per annum will comprise opex (35%) as well as capex (65%): about [✂] opex as well as the [✂] capex. In light of this, we have also considered whether the opex allowance in the charge control provides sufficient funding. To get a better understanding of the FVR

[228] Net Replacement Cost.

[229] Operating Capital Maintenance (OCM) depreciation is the reduction in value (as measured by their Gross Replacement Cost (GRC)) of the assets over the course of the financial year associated with the reduction in the asset's remaining life.

[230] September 2017 Consultation, paragraphs 3.81-82.

[231] Average annual capex for WLR and MPF services during the control period, as forecast in 2017 WLA charge control model.

[232] The capex allowed in the charge control will include spend on some activities not included in Openreach's actual 2015/16 capex for WLR and MPF, e.g. FTTP new build.

opex included in Openreach's plan, we have gathered information using our powers on the breakdown of FVR opex by sub-programme, as shown in Table A13.5 below.

Table A13.5: Openreach FVR opex by sub-programme

Sub-programme	Description	2015/16 (£m nominal)	2016/17 (£m nominal)
B058 FVR - Joint Remakes (Non-pressurised)	Visit by engineer to repair/uplift a D side joint in the cable from PCP to the distribution point. (Joints are primarily used to provide flexibility points, or when cabling length limits are reached)	[✂]	[✂]
B058 FVR - UELP Pressure Maintenance	Survey cables leaving the telephone exchange to try and find any leaks in the cable which may allow ingress of water. Will be fixed if simple otherwise submit proposal for renewal to planners to raise capex estimate	[✂]	[✂]
B058 FVR - M Side Survey[233]	Work by engineer to investigate M Side – anything from the exchange to the PCP – work out where the faulting part of the network is and if quick fix, fix, or if capital work, submit proposal for fix to planners to build capex estimate	[✂]	[✂]
B058 FVR - D Side Survey	Work by engineer to investigate D Side – anything from the PCP to the distribution point (overhead pole) – work out where the faulting part of the network is and if quick fix, fix, or if capital work, submit proposal for fix to planners to build capex estimate	[✂]	[✂]
Other sub-programmes		[✂]	[✂]
Total		**[✂]**	**[✂]**

Source: Openreach response to Q7 of 8th QoS s.135 notice of 23 June 2017

A13.39 Table A13.5 shows that the largest sub-programme, accounting for 40% of spend in 2016/17, involves repairing/uplifting D-side cable joints and that the remainder of the opex costs are mostly on engineers surveying different parts of the network and then either carrying out quick fixes where possible or submitting proposals to raise capex for bigger jobs like renewals. This type of expenditure is similar to capex in that it is used to upgrade the network and will prevent Openreach having to reactively repair faults. However, it would be reasonable to treat such costs as opex where the benefits of the spend is likely to last for less than a year (and hence to maintain quality levels a similar level of expenditure would be required each year).

A13.40 In this regard, we note that Openreach's plan includes maintaining a relatively constant level of FVR opex in each year over the medium term.[234] In addition, BT's accounting policy will consider how long the economic benefits last for when deciding whether to expense costs in-year (i.e. treating as opex) or spread them over a number of years (i.e. treating as

[233] Openreach define M-side as anything from the exchange to the PCP, which we note this is similar to our definition of the E-side of the network.
[234] Openreach response to question 1 of the 7th QoS s.135 notice of 5 June 2017.

capex).[235] On this basis, we disagree with TalkTalk that all of the benefits of such expenditure would last for many years into the future – the expenditure of the type set out in Table A13.5 may yield shorter lasting benefits and would have to be renewed on an ongoing basis (e.g. each year).

A13.41 We therefore consider it reasonable that our opex forecast covers expenditure on FVR. We disagree with Vodafone that it would be appropriate to offset the capex allowance by the allowance for FVR in the opex forecast. As set out above, we forecast capex on the basis of an ongoing network with a steady state adjustment. This approach applies to all assets, including those that are unrelated to the level of faults, and is intended to provide efficient pricing signals. It is not intended to match precisely Openreach's actual capex. We do not include an explicit capex allowance for FVR expenditure as this would amount to a double-count when combined with the ongoing network and a steady state adjustment approach. We do not therefore consider it is appropriate to adjust the level of capex allowance for the FVR programme.

A13.42 In terms of the amount of FVR opex that needs to be recovered, according to the latest view of Openreach's Medium Term Plan (MTP) provided on 9 June 2017, Openreach is expecting to spend about [✂] FVR opex per annum during the charge control period.[236] Table A13.5 above shows that actual spend in 2016/17 was [✂]. Hence, having updated the base year to 2016/17, we conclude that there is an appropriate allowance for FVR opex within our modelled cost base.

QoS standards resource uplift assumptions (step (c))

A13.43 For Openreach to achieve higher QoS standards and still recover its efficiently incurred costs, there is a need to increase repair costs to account for the additional engineer resource needed.

A13.44 As set out in Section 10 and Annex 3 of the 2018 QoS Statement, we have carried out a detailed assessment of the impact on Openreach's engineering resource of increasing its performance in line with the QoS repair standards we have put in place. This has involved using the outputs of our RPM as well as taking account of additional insights provided by Openreach's Allocation model on the relationship between quality of service standards and costs. Overall, we forecast a proportional increase of 14.1% in Openreach's repair costs to meet the higher QoS standards by the end of the control period. Table A13.6 below sets out our estimates for SML1 and SML2.

Table A13.6: QoS repair standards (excluding adjustment for *force majeure*[237]) and forecast resource uplifts to achieve them

	2018/19	2019/20	2020/21
Repair standards (% by SLA)	83%	86%	88%

[235] For example, see 2017 BT Group Annual Report, 'Significant accounting policies' pages 176-81.
[236] Openreach response to question 1 of the 7th QoS s.135 notice of 5 June 2017.
[237] A fixed allowance of 3% to take account of events such as severe storms and flooding which are beyond Openreach's reasonable control.

Uplift for all SMLs	4.7%	9.4%	14.1%
Uplift for SML1	3.9%	7.9%	11.8%
Uplift for SML2	5.5%	10.9%	16.4%

Source: Ofcom analysis

A13.45 As set out above, we have applied these uplifts to the forecast repair costs that have already been adjusted for the FVR reduction. As Table A13.6 shows, the level of the resource uplift depends on the SML, with SML2 requiring a larger increase in effort than SML1. To determine an appropriate resource uplift for each component in the repair cost model, we put each component into one of the following categories:

- Shared repair components: repair related components that are shared across WLR and MPF services. The level of the resource uplift is determined by the current SML mix across all WLR and MPF volumes.
- WLR specific repair components: repair related components that are used only by WLR services. The level of the resource uplift is determined by the current SML mix for WLR services.
- MPF specific repair components: repair related components that are used only by MPF services. The level of the resource uplift is determined by the current SML mix for MPF services.

A13.46 As GEA FTTC services are currently supplied on the basis of SML2 only, in our bottom-up model (discussed in Annex 14) we have applied the SML2 resource uplifts in order to take account of the higher repair standards.

A13.47 As shown in Table A13.7 below, the QoS standards resource uplifts result in an increase of £2.01 and £0.69 on the MPF and GEA 40/10 rental unit costs respectively in 2020/21 (compared to a counterfactual of repair costs that include the effect of fault reduction only). These impacts are larger than those calculated for the September consultation. As with the FVR adjustment, this is because the base year repair costs are now larger. In addition, the level of the resource uplift is higher. As set out in the 2018 QoS Statement, this represents the upper end of our consultation range and was arrived at following our assessment of responses and further evidence.

Table A13.7: Impact of Resource uplifts on unit costs (£ nominal, annual)

	2018/19	2019/20	2020/21
MPF rental unit cost	+£0.68	+£1.34	+£2.01
GEA 40/10 rental unit cost	+£0.28	+£0.51	+£0.69

Source: Ofcom modelling

Further efficiencies (step (d))

A13.48 Having taken into account the impact of our QoS improvement targets on repair costs for copper services, we need to make an assumption on the extent of any further savings Openreach can achieve over the period. Unlike our FVR analysis, for further efficiencies we have not identified the individual drivers or work-programmes affecting repair costs but intend to capture all additional cost savings across the direct and indirect costs. This could include but is not limited to savings due to: reductions in task times, improvements in operational processes, and technological advances.

A13.49 We have estimated further efficiencies for repair costs by assessing BT's top-down historical and forecast accounting information using a similar approach to our assessment of non-repair costs, which is described in detail in Annex 19. In summary, we use the following data sources:

- <u>BT's regulatory cost data on historical cost savings:</u> we have identified repair costs (and non-repair costs) on the basis of the same approach used for the base year (2016/17) costs, as described above.
- <u>BT's management accounting data on historical and forecast cost savings:</u> we used the costs of Openreach's Service Delivery organisation in our analysis as we consider this represents a reasonable proxy for the relevant repair costs (as discussed in Annex 19).

A13.50 In relation to the historical assessment of repair costs, we have carried out our analysis between 2012/13 and 2016/17 by estimating how much of the annual movement in costs was due to inflation and how much was due to changes in volumes (using CVEs) and assumed that efficiency accounts for any remaining movement. Our estimates of efficiency gains for repair costs in each of the four year-on-year comparisons, based on both the regulatory cost and management accounting data, are set out in Table A13.8 below.

Table A13.8: Estimates of historical efficiency for copper services repair costs

	13/14	14/15	15/16	16/17	CAGR
BT regulatory cost data	[✂]	[✂]	[✂]	[✂]	3.1%
BT management account data	[✂]	[✂]	[✂]	[✂]	2.7%

Source: Ofcom analysis of BT data

A13.51 The average annual efficiency gains between 2012/13 and 2016/17 are 2.7% to 3.1% per annum. While there are significant variations between individual years within the regulatory cost and management account data, the estimates across the period are consistent between the two data sources. As noted in the March consultation, during this period fault rates did not decrease (or increase) significantly.[238] Therefore, as the observed cost savings were not driven by fault reduction, they are likely to represent further efficiencies.

A13.52 In relation to the forward-looking assessment of repair costs, we have estimated BT's forecast of efficiency by analysing its forecast management accounting data for the period 2016/17 to 2020/21. The forecasts form part of the September 2017 BT Group business plan and reflect BT's latest view of achievable savings. Table A13.9 below sets out our estimates of BT's forecast efficiency gains.

[238] See 2018 QoS Statement, Annex 1 for details on historical fault rates.

Table A13.9: Estimates of forecast efficiency for copper services repair costs

	17/18	18/19	19/20	20/21	CAGR
BT management account data	[✂]	[✂]	[✂]	[✂]	3.3%

Source: Ofcom analysis of BT data

A13.53 The average forecast annual efficiency gains between 2016/17 and 2020/21 shown in Table A13.9 is 3.3%. However, we recognise that care must be taken when interpreting these forecasts due to the QoS improvements Openreach is expected to make during this period. In particular, BT's management account cost forecasts will include the effects of the planned fault rate reduction (reducing costs) and the QoS uplift (increasing costs). Hence, to convert the forecast BT management account estimates into forecast further efficiency estimates, we have adjusted for the effects of these QoS improvements:

- <u>Fault rate reduction:</u> as set out above, for copper services (WLR, MPF and SMPF) we expect a reduction in the fault rate of [✂] (10-13%) over the forecast period, which translates to a [✂] (2-3%) reduction per annum. As set out in the 2018 QoS Statement, Openreach considered that the overall fault rate reduction we have forecast is in line with its expectations.[239] On this basis, we consider that our fault rate forecast is suitable for estimating the effect of FVR within the BT management account forecasts.
- <u>QoS uplift:</u> we have assumed a 14.1% increase in repair costs is needed for Openreach to meet the 88% on-time repair standard. However, as set out in the 2018 QoS Statement, Openreach's Allocation Model forecasts a slightly higher uplift at 14.6%. In addition, according to BT's September 2017 BT Group business plan its management account forecasts have been modelled on the basis of achieving 86% of on-time repairs.[240] On this basis, we have used BT's assumptions to estimate the impact of the QoS uplift within the BT management account forecasts of c.11%.[241] This translates to a 2.6% per annum increase in costs.

A13.54 Our estimate of BT's management accounts annual forecast efficiency for repair costs, having taken into account the effect of these QoS improvements is set out in Table A13.10 below. It shows that, net of cost changes due to fewer faults and the QoS uplift, BT expects efficiency savings of [✂] (2.5-3.5%) per annum over the next four years for its repair costs.

Table A13.10: Estimates of BT management account forecast efficiency for copper services repair costs, net of QoS effects (2016/17 to 2020/21)

	CAGR
BT management account data: pre-adjustments	3.3%
Fault reduction impact	[✂] -(2-3%)

[239] 2018 QoS Statement, Section 4.
[240] Openreach response dated 4 January 2018 to question 1 of the 43rd s.135 notice.
[241] This assumes 80% on-time repair as the starting point and a linear relationship between performance and costs. Therefore achieving 86% on-time repairs will require 75% of the uplift required to achieve 88% on-time repairs, i.e. (86% - 80%)/(88% - 80%) = 75%. We have then applied this to Openreach's estimated QoS uplift: 14.6% * 75% = 11%.

QoS uplift impact	+2.6%
BT management account data: post-adjustments	[✂] (2.5-3.5%)

Source: Ofcom analysis of BT data

A13.55 BT's forecasts therefore suggest it expects to achieve a similar level of further efficiency to its historical rate. We consider that the similarity between the two periods is consistent with the fact that in each period Openreach has been required by regulation to improve its QoS. Whereas we recognise that in the forecast period Openreach is planning to provide a repairs service that is closer to its operational limit and deliver a lower fault rate than previously, we would also expect it to become more efficient over time at delivering better QoS due to 'learning by doing' effects. For example, Openreach has gained experience of improving its repair performance since the standards were introduced in 2014. Similarly, we would expect it to improve its processes for services that were relatively new during the last review period but are now becoming more mature such as GEA-FTTC (as noted in the 2018 QoS Statement, Section 4).

A13.56 Our analysis of BT's historical and forecast cost data suggests that a range of [✂] (2-4%) is reasonable for the further efficiencies assumption. To determine our point estimate, we have taken into account the likely margin for error within our estimates. For example, as discussed above, to interpret the forecast data we have had to make assumptions to estimate the likely effect of the expected QoS improvements – while we have assumed a linear cost curve to estimate the QoS uplift BT has used within its forecasts, in practice the cost curve may have a different profile. In addition, we recognise there is uncertainty about the precise impact on the costs of Openreach improving its repair performance beyond what it has historically achieved, alongside carrying out an enhanced fault reduction investment programme.

A13.57 We have therefore decided that a further efficiency assumption for repair costs at the lower end of the range, at [✂] (2-3%) per annum, is appropriate. We consider that this represents a stretching but achievable target and is consistent with our charge control objectives set out in Section 2.

QoS usage factors and service level differentials (step (e))

A13.58 The final part of the repair cost model concerns the conversion of the repair costs by component into service costs. As set out in Annex 12, this is carried out by applying usage factors to the component costs.

A13.59 We have adjusted BT's usage factors to account for the relative fault rates of the different services (MPF, WLR and SMPF), as well as the different service level mixes for the services. Consistent with our approach in the September consultation, we have carried out the adjustment by normalising the WLR and SMPF usage factors relative to an MPF usage factor we have set to 1.13, resulting in a WLR usage factor of [✂] and SMPF usage factor of [✂] in 2020/21. As intended, this results in lower component costs and volumes being attributed to MPF and more to WLR and SMPF (compared to BT's usage factors) but ensures that overall component costs and volumes are not impacted by the adjustment, i.e. the summed component costs and volumes across MPF, WLR and SMPF calculated using QoS usage factors are the same to those calculated using BT's usage factors.

A13.60 Second, we disaggregate MPF and GEA repair costs into SML1 and SML2. We have used the outputs of the RPM developed for our 2018 QoS Statement to understand the differential in resources required to provide services at SML1 rather than SML2. This model assesses the change in effort (i.e. reduction in resource required) when moving from SML2 to SML1. The outputs we used to disaggregate by service level are shown in Table A13.11 below.

Table A13.11: Change in resource for each percentage point change in SML mix at different repair standard levels

	2018/19	2019/20	2020/21
Repair standard	83%	86%	88%
SML1 to SML 2 differential	1.5%	3.1%	4.6%

Source: Ofcom modelling

A13.61 We have used these differentials along with forecast service volumes and service level mixes to calculate the repair costs for the two services for which we have imposed a charge control, MPF at SML1 and GEA FTTC 40/10 at SML2. Table A13.12 summarises the impact of our main assumptions on the repair costs for MPF SML1 and GEA FTTC 40/10 SML2 rentals in 2020/21.

Table A13.12: Impact of modelling assumptions on 2020/21 MPF SML1 and GEA FTTC 40/10 SML2 repair costs (£ nominal, annual)[242]

	MPF rental SML1	GEA FTTC 40/10 SML2
FVR adjustment	-2.59	-0.53
Resource uplift	+2.01	+0.69
Further efficiencies	-1.57	N/A

Source: Ofcom modelling

Service Level Guarantee (SLG) payment costs

A13.62 Service Level Guarantees (SLGs) are compensation that a purchasing telecoms provider is entitled to should Openreach not provide a service to the quality specified in the Service Level Agreement (SLA), e.g. if delivery or repair of the service is late.

A13.63 We expect our quality of service improvements to decrease Openreach's SLG payment volumes, while the voluntary scheme on retail automatic compensation[243] is likely to

[242] Estimated using iterative approach, where: starting point is costs before QoS or efficiency assumptions, FVR adjustment is calculated comparing to before QoS or efficiency assumptions, Resource uplift is calculated comparing to FVR adjustment, and Further efficiencies is calculated comparing to Resource uplift.

[243] Ofcom, 2017. *Automatic Compensation – Statement*.

increase the cost per SLG payment as telecoms providers negotiate changes to the SLG regime to reflect the additional costs when Openreach misses agreed timescales.

A13.64 Consequently, as set out in Annex 12, we have removed Openreach SLG costs from the base year 2016/17 costs and have modelled them separately. This section sets out how we have modelled SLG costs, summarising our proposals in the March and September consultations, stakeholder responses and any further analysis and evidence we have taken into account in reaching our decisions.

Our proposals

A13.65 In the March consultation, we proposed forecasting SLG payments separately to take into account the expected improvements in Openreach's QoS performance using the following formula:

Relevant volumes x SLG event rate[244] x average payable days[245] x the daily SLG payment (£)[246]

A13.66 In forecasting repair SLGs, we proposed to use an average payable days assumption corresponding to Openreach's best historical performance between 2011/12 and 2015/16 and assume that this stayed flat throughout the forecasting period. In addition, in forecasting each of the SLG types,[247] we proposed to base our assumptions on the SLG event rate and average payable days on Openreach's best performing year between 2011/12 and 2015/16 for each service separately.

A13.67 In the September consultation, following further evidence submitted by Openreach, we proposed modifying our approach. First, for repair SLGs we proposed, taking into account that as Openreach repairs a higher proportion of faults within the SLA in line with the increasing QoS repair standards, that the average payable days of repairs not completed within the SLA (and incurring SLGs) will likely increase as, on average, these will be more complex in nature and take longer to repair. Second, for all SLG types, rather than basing SLG volumes and average payable days on the best performing historical year, we proposed to base our assumptions on performance in the base year (2015/16) to account for the interdependency between repair and provision activities within Openreach's Service Delivery unit.

Summary of responses

A13.68 Openreach[248] and Virgin Media[249] both agreed with our proposed amendments to the SLG forecasting approach in the September consultation, stating that they more accurately

[244] The SLG event rate = the proportion of the relevant service volumes (either rentals or connections) that will incur SLGs over the course of a year.
[245] For each instance where an SLG is triggered, the average number of days SLGs are payable for.
[246] March 2017 WLA Consultation, paragraphs A11.171-A11.181.
[247] Repair SLGs, Provision SLGs, First Available Date (FAD) SLGs, Dead on Arrival SLGs and Missed Appointments SLGs.
[248] Openreach response to the September 2017 WLA Consultation, paragraphs 95-97.
[249] Virgin Media response to the September 2017 WLA Consultation, response to question 3.3 on page 5.

reflect the repair activity that Openreach will have to complete as the repair standards increase because faults will be more complex on average due to the higher proportion of glass ceiling jobs. Openreach added that using the base year SLG costs across provision and repair as a starting point for forecasting future payments was more realistic and accurate.

A13.69 Vodafone argued that BT incurring additional SLG costs in the future is highly subjective and speculative and that it would prefer us to base our modelling on Openreach's actual costs incurred, rather than Openreach's projections. Vodafone believed that while allowing Openreach to recover compensation costs is economically sound, the increase is unpalatable and should be highly scrutinised. Vodafone added that this approach does not take into account the incremental costs that telecoms providers face as a result of Openreach's failure to deliver a service.[250]

A13.70 TalkTalk commented that the increase in forecast SLG costs of c.£0.80 for MPF rental charges between the March and September consultations was substantial and lacked transparency. It believed that our assumptions significantly overestimated SLG payment costs and argued that the increase in average payable days appeared too high. TalkTalk also queried the increase in SLGs due to automatic compensation as there was no firm commitment from Openreach to increase its SLGs and not all telecoms providers have agreed to pay automatic compensation.[251]

A13.71 Sky and UKCTA also commented on the impact of automatic compensation. Sky considered that the new lower automatic compensation levels agreed in the voluntary industry code of practice (compared to Ofcom's consultation proposals) should be taken into account in the charge control.[252] UKCTA argued that Openreach's incentives to improve service beyond the QoS standards were substantially diminished by the inclusion of the additional automatic compensation costs in the charge control.[253]

Our reasoning and decisions

Modelling approach

A13.72 In any industry, we would expect an efficient firm to have to pay some level of compensation for failure to deliver a service. In the case of Openreach's WLA services, the resource commitments that would be required to ensure that SLAs are always met are likely to be very significant and involve QoS costs that would be above an efficient level. Allowing the recovery of some SLG payments through charges is therefore consistent with one of our charge control objectives of allowing BT the opportunity to recover its efficiently incurred costs.

A13.73 While Openreach currently pays SLGs to its customers and these will be captured in the base year costs, we do not consider this to be an appropriate basis for calculating SLG costs

[250] Vodafone response to the September 2017 WLA Consultation, pages 6-7.
[251] TalkTalk response to the September 2017 WLA Consultation, paragraphs 3.7-3.14.
[252] Sky response to the September 2017 WLA Consultation, paragraphs 6.29-6.31.
[253] UKCTA response to the September 2017 WLA Consultation, paragraph 13.

for the charge control. Firstly, we are expecting Openreach to achieve a higher level of quality of service in the future and this will lead to fewer SLG payments. In practice, it is difficult to precisely specify the level of quality that an efficient operator would provide. However, our proposals on quality standards and fault rates represent the lower bound of what we would expect an efficient operator to be able to achieve. Secondly, we are expecting the payment per SLG to increase to reflect the additional costs of Openreach service delivery due to automatic compensation. Therefore, rather than using Openreach's actual costs as suggested by Vodafone, we have maintained our consultation approach of forecasting SLG payments as follows:

- remove SLG payments from the base year costs[254]; and
- forecast SLG payments on a bottom-up basis incorporating improvements in Openreach's QoS performance (e.g. fault rate, the proportion of repairs within SLA and average duration of SLGs), taking into account the likely impact on the daily SLG payments of the automatic compensation industry code of practice.[255]

A13.74 We have forecast each type of SLGs using the following formula:

> Relevant volumes x SLG event rate[256] x average payable days x the daily SLG payment (£).

A13.75 For repair SLGs, the SLG event rate has been derived on the basis of: the fault rate x (1-repair standard %).[257] As set out above, we are expecting the fault rate to decrease and Openreach to meet an increased on-time repair standard during the control period. Therefore, we have maintained our consultation approach of taking these effects into account leading to an SLG event rate that decreases over time.

A13.76 In relation to average payable days, as proposed in the September consultation, we have assumed an increase in the average payable days for repair SLGs as Openreach's repair performance improves in line with the QoS standards. This approach more realistically captures the dynamics of SLGs as QoS improves (versus assuming average payable days stay flat). This is supported by Openreach data which shows a breakdown of the average payable days of the SLGs it incurred in 2016/17, depending on whether repairs are classed as 'glass ceiling' jobs or not (as shown in Table A13.13 below). As set out in the 2018 QoS Statement (Figure 6.3), Openreach considered 'glass ceiling jobs' as those that require civil engineering, specially skilled engineers or specialist equipment, while non-glass ceiling jobs are ones that are generally more straightforward to complete, provided there are sufficient resources.

[254] March 2017 WLA Consultation, paragraphs A11.113-115.
[255] March 2017 WLA Consultation, paragraphs A11.162-181.
[256] The SLG event rate = the proportion of the relevant service volumes (either rentals or connections) that will incur SLGs over the course of a year.
[257] For example, a fault rate of 10% and a repair standard of 85% would result in an SLG rate of: 10% * (1 – 85%) = 1.5%.

Table A13.13: Openreach analysis of [average] payable days by job type using 2016/17 actual data (days)

	WLR	MPF	GEA
Non-glass ceiling	1.87	1.65	1.73
Glass ceiling	5.18	5.58	5.34

Source: Openreach

A13.77 Table A13.13 shows that the average payable days for glass ceiling jobs was 2-3 times that of non-glass ceiling jobs. As set out in the 2018 QoS Statement, our standard of 88% on-time repair for 2020/21 reflects our view of a level of performance that gets closer to Openreach's operational limit (i.e. the glass ceiling).[258] Hence, a consequence of Openreach achieving the 88% standard will be that the 12% of repair jobs that fail the SLA will predominantly be the 'glass ceiling' jobs that take longer to resolve. It is because of this change in mix of glass ceiling jobs vs non-glass ceiling jobs that we expect the average payable days for SLGs to increase.

A13.78 As part of the process of updating and refining our analysis for this statement, we have gathered and checked Openreach's underlying data on average payable days by job type. The source data is Openreach's 'RD3' database which contains the on-time performance for all its repair jobs in 2016/17. This is the official measure used to report performance against the QoS standards to Ofcom and is also the data we have relied on in our assessment of Openreach's quality of service performance that is set out in Annex 1 of the 2018 QoS Statement.[259] In relation to stakeholders' responses on the extent to which average payable days is expected to increase, this is supported by the RD3 data which shows an upward-sloping trend for average payable days towards the upper-end of Openreach's operational capability, whereby the rate of increase in average payable days is larger than the rate of increase in SLG volumes. Table A13.14 below sets out the average payable days we have used to forecast repair SLGs.

Table A13.14: Revised average payable days used to forecast repair SLGs[260]

2018/19	2018/19	2018/19
3.10	3.13	4.24

Source: Ofcom modelling

A13.79 For other aspects of Openreach's service which have SLGs – on-time provision, first available date (FAD) and dead on arrival (DOA) – Openreach was performing close to or beyond our proposed standards.[261] As the standards do not require material performance

[258] September 2017 QoS Consultation, paragraphs 3.34-37.
[259] Openreach response to question 11 of 43rd s135 of 14 December 2017, received on 4 January 2018.
[260] As the Openreach data used to estimate these average figures is based on full SLG payable days, we have not carried out any further rounding in our forecasting calculations.
[261] For example, as set out in the 2018 QoS Statement, Openreach has delivered 90-95% on-time provisions (i.e. installations) since August 2012 (paragraph 6.28). We are introducing a 95% standard for on-time provision.

improvements for these aspects, compared to Openreach's actual performance in the base year, we consider historical performance to provide appropriate benchmarks for our assumptions on SLG event rates and average payable days.

A13.80 As set out in the September consultation, we recognise that Openreach uses a common pool of engineer resource to carry out its operations and often flexes its resources between fault repairs and provision activities during peak times.[262] In light of this, we have assessed Openreach's historical performance as follows:

- We consider that historical performance on SLG event rates and average payable days should be assessed for all products in aggregate (but applied separately to the relevant volumes of each product).[263] This reflects that when Openreach is making resourcing decisions it will trade-off the resources needed to complete the work across all of its products (e.g. WLR, MPF, GEA).
- We also consider that this suggests that the base year is likely to represent the most appropriate benchmark. As set out in the 2018 QoS Statement, Openreach's repair performance was worse in prior years.[264] Given the inter-related nature of Openreach repair and provisioning performance, we consider it would be inappropriate to base assumptions on provisioning performance on a year in which repair performance was unrepresentatively poor.

A13.81 For this statement, consistent with our approach to other types of costs in the top-down model, we have updated our analysis to use 2016/17 performance as the starting point for forecasting provision, FAD and DOA SLGs. In addition, we have maintained our approach of using the average SLG event rates and average payable days across <u>all</u> products in 2016/17. Table A13.15 below sets out our assumptions for provisions, FAD and DOA SLGs.

Table A13.15: Assumed event rates and average payable days for provisions, FAD and DOA SLGs

	MPF	WLR	GEA
Provision SLG event rate	[✂]	[✂]	[✂]
Provision SLG avg payable days	[✂]	[✂]	[✂]
FAD SLG event rate	[✂]	[✂]	[✂]
FAD SLG avg payable days	[✂]	[✂]	[✂]
DOA SLG event rate	[✂]		
DOA SLG avg payable days	[✂]		

Source: Ofcom modelling

A13.82 Missed appointment SLGs are slightly different in that they are a fixed one-off compensation payment when the event occurs (i.e. when an engineer misses an

[262] March 2017 QoS Consultation, paragraph 6.73.
[263] For example, for repair SLGs we calculate the average historical SLG event rate and average payable days across all products in a given year. We then apply these to the forecast line volumes and daily SLG payments for each product individually.
[264] For example, see March 2017 QoS Consultation, Figure 5.4.

appointment), rather than varying by the number of payable days. Therefore, to forecast missed appointment SLGs we use the following formula: connection volume x event rate x SLG per event. Consistent with the other SLG types, we used the average event rate across all products in 2016/17. Table A13.16 sets out our assumptions for missed appointment SLGs.

Table A13.16: Assumed event rates for missed appointment SLGs

	MPF	WLR	GEA
Missed appointment event rate	[✂]	[✂]	[✂]

Source: Ofcom modelling

Impact of QoS improvements

A13.83 As set out above, we derive the event rate for repair SLGs on the basis of assumptions on QoS improvements in terms of fault rates and the proportion of SLAs met in accordance with the proposed repair standards. Our decision on the package of QoS remedies that we have put in place is set out in the 2018 QoS Statement and includes fault rate forecasts and repair standards during the charge control period. Tables A13.17-A13.19 set out the revised fault rates, repair standards and the resulting SLG event rates we have calculated.

Table A13.17: Assumed fault rates for SLG calculation

	2018/19	2019/20	2020/21
WLR	[✂]% (7-8%)	[✂]% (7-8%)	[✂]% (6-7%)
MPF	[✂]% (10-11%)	[✂]% (9-10%)	[✂]% (9-10%)
GEA	[✂]% (12-13%)	[✂]% (11-12%)	[✂] (11-12%)

Source: Ofcom modelling

Table A13.18: Proposed repair standards (*excluding adjustments for force majeure*)

	2018/19	2019/20	2020/21
WLR	83%	86%	88%
MPF	83%	86%	88%
GEA	83%	86%	88%

Source: Ofcom modelling

Table A13.19: Calculated repair SLG event rates (fault rate x (1-repair standard))

	2018/19	2019/20	2020/21
WLR	[✂]	[✂]	[✂]
MPF	[✂]	[✂]	[✂]
GEA	[✂]	[✂]	[✂]

Source: Ofcom modelling

A13.84 Our SLG forecasts also take into account expected changes in the daily SLG payments over the control period. The current daily SLG payments are intended to represent the detriment to telecoms providers' arising from Openreach failing to meet the SLAs and have been derived on the basis of a number of factors including current rental prices and estimates of telecoms providers' losses. Specifically, for MPF and GEA 40/10 repair SLGs, which are set on the basis of rental prices, we have taken into account the impact of the charge control using the CPI-X model.[265]

A13.85 We also take into account the introduction of retail automatic compensation for loss of service, late provisioning and missed appointment incidents during this period.[266] We have updated the assumed daily SLG payments on the basis of the retail automatic compensation payments agreed by telecoms providers in the voluntary industry code of practice. In this regard, we note that all major telecoms providers have signed up to this agreement and we therefore consider it reasonable to uplift the daily SLGs payable on all lines. In addition, we have further refined our approach by taking into account the differences in timing between when retail automatic compensation and SLGs are payable for loss of service/late repairs:

- First, automatic compensation is payable on a calendar day basis (i.e. 7 days a week), whereas repair SLGs for SML1 are on a Monday to Friday working-day basis and SML2 are on a Monday to Saturday working-day basis. To account for this we have uplifted the increase due to automatic compensation by 40%[267] for SML1 and 17%[268] for SML2.
- Second, automatic compensation is triggered if a fault is not repaired within two working days. While this approximately matches with the SML1 repair SLG trigger point, SML2 repair SLGs are payable after 1 day. Hence, we have scaled down the SML2 increase due to automatic compensation by c.33%, which is the difference between the two trigger points divided by the average payable days.

A13.86 We have applied these two adjustments in proportion to the mix of SML1 and SML2 of each service (WLR, MPF, SMPF and GEA 40/10).

A13.87 Having updated these assumptions on improvements in QoS and the daily SLG amounts, we have combined them with the assumptions on event rates and average payable days set out above to calculate the forecast of SLG payments set out in Table A13.20 below.

Table A13.20: Forecast payments by SLG type over the charge control period for WLR, MPF, SMPF and GEA-FTTC (£m, nominal)

	2018/19	2019/20	2020/21

[265] We have assumed that the prices of products we are not charge controlling, e.g. WLR and SMPF, will stay fixed in nominal terms to the end of the charge control period.
[266] In our forecasting, we assumed that the retail automatic compensation resulting from Openreach network faults will get fully passed through to the SLGs Openreach pays retail telecoms providers from the beginning of 2019/20 onwards.
[267] On the basis that 7 days a week (over which automatic compensation will apply) is 40% longer than 5 days a week (over which SML1 applies).
[268] On the basis that 7 days a week (over which automatic compensation will apply) is 17% longer than 6 days a week (over which SML2 applies).

Repairs	12.0	23.6	27.3
Provisions	19.6	31.2	29.0
FAD	3.3	3.2	3.0
Missed Appointments	5.8	8.7	8.9
Dead on Arrival	8.5	8.3	8.1
Total	49.1	75.0	76.3

Source: Ofcom modelling

A14. Bottom-up model: documentation

A14.1 In Section 4 we explained that we have used a bottom-up model to calculate the LRIC of the controlled GEA 40/10 service. In this annex we set out the approach underpinning this model, including the choice of technology, geographic coverage, scope of the network being modelled and the depreciation method used. We also discuss the data sources and key modelling assumptions we have used which are not covered in detail in the Cartesian Report (Annex 29).[269]

A14.2 This annex should be read alongside the Cartesian Report (Annex 29), which provides details of how we have calculated the amount of equipment required for our modelled fibre to the cabinet (FTTC) network and identified the costs associated with that equipment, and Annex 15, which explains our approach to calibrating the bottom-up model. Annex 16 summarises the outputs of the bottom-up and top-down models as well as the associated sensitivity and scenario analysis.

A14.3 In finalising our approach to estimating the unit LRICs of FTTC services, we have taken account of responses to our consultation proposals from May 2016 and March 2017 as well as information provided by stakeholders throughout this process. In particular, Openreach has provided us with information on its updated next generation access (NGA) business case which we have considered and used where appropriate when updating our modelling.

Summary of our approach

A14.4 We have decided to adopt the following approach to our modelling:

- use a bottom-up approach to estimate the incremental costs of an efficient national fibre network;
- consider FTTC as the proven modern equivalent asset (MEA) technology for modelling fibre access in the UK;
- adopt an anchor pricing approach by which we would base the regulated GEA 40/10 price on the costs of providing the service over an ongoing FTTC overlay network;
- dimension the modelled network based on BT's existing copper network (i.e. a scorched node approach);
- exclude areas subject to public subsidy from the modelled network footprint; and
- use CCA depreciation to determine the profile of cost recovery over time.

[269] We do not cover details of the model design, structure and implementation as these are discussed in Section 4.

Key modelling assumptions and data sources

A14.5 Where issues are not covered in detail in the Cartesian Report, we set out our key assumptions in the relevant sub-sections below. We also discuss the data sources we have used to populate our model.

A14.6 In light of consultation responses and further information provided by stakeholders, we have updated a number of our inputs and assumptions since our March consultation, including our assumptions on the asset lives, the costs of deploying vectoring, additional FTTC cabinets and general management costs.

Conceptual approach to cost modelling

Choice of fibre access technology

A14.7 The purpose of our model is to calculate the cost of providing fibre services in the UK. A number of different approaches can be used to deploy an access network in order to provide the controlled GEA 40/10 service. Therefore, we have determined the costs of an efficient fibre access network on the basis of an appropriate proven efficient technology for providing nationwide fibre access.

Our proposals

A14.8 In our March consultation we proposed an anchor pricing approach. This is a well-established methodology which we have used in the past to protect existing customers during the introduction of new technologies, whilst still incentivising efficient investment. For instance, investment in newer technologies is incentivised when the new technology represents a more cost-effective way of delivering the service or when it enables the provision of new and enhanced services for which customers are prepared to pay a price premium.

A14.9 We explained that FTTC is currently the predominant technology used for delivering fibre services in the UK, although we recognised that newer technologies are likely to emerge and get deployed over the charge control period. We said that the uncertainty around the costs and technical features of these new technologies meant that FTTC continues to be the proven modern equivalent asset (MEA) for modelling fibre costs.

A14.10 We also said that to deal with such uncertainty we were minded to adopt an anchor pricing approach and model the costs of an ongoing FTTC overlay network over the entire time span of the bottom-up model. This is consistent with the approach we have taken in previous charge controls where we have regulated access prices based on the legacy technology (i.e. copper).

Stakeholder responses

A14.11 Only Vodafone and CityFibre commented on our proposed choice of technology in the bottom-up model.

A14.12 Vodafone disagreed with our anchor pricing approach as a matter of principle. It argued that by basing the costs on FTTC we would "enable BT to continue to run and use the older technology for longer".[270] It therefore suggested "to model the most up to date technology available and base the charge control model on the most efficient technology available".[271]

A14.13 CityFibre argued that our choice of technology does not take into account the efficiencies that can be achieved by the deployment of FTTP technology at scale. It noted that "FTTP is able to deliver lower unit costs than BT's FTTC network at competitive levels of market share, and that this suggests that FTTP would clearly be a more appropriate MEA".[272]

Our reasoning and decision

A14.14 As noted above, our use of an anchor pricing approach aims to strike an appropriate balance between protecting consumers from high prices in the short term and incentivising efficient investment in new technologies in the longer term.

A14.15 We believe that an anchor pricing approach is wholly consistent with CityFibre's view that FTTP would deliver fibre services at a lower cost than FTTC. If this is the case, by anchoring the GEA 40/10 price to the cost of a national FTTC network, competing operators could deploy lower cost FTTP networks and make a profit by matching the controlled GEA 40/10 price. Moreover, telecoms providers could use these new networks to deliver higher quality fibre services and be able to charge a price premium. In Volume 1, Section 9, we pointed out that this premium could be in the range of £2.55 to €15 per month over and above the controlled GEA 40/10 price.

A14.16 As noted in Volume 1, Section 5, a number of telecoms providers other than BT have expressed interest in network investment. Recent examples include the CityFibre/Vodafone deal to rollout FTTP to 1m premises (and potentially to 5m premises)[273] and the recent announcement that TalkTalk is in discussions to deliver FTTP to 3m premises[274] showing the potential for FTTP rollout envisaged under our anchor pricing approach.

A14.17 The deployment of full fibre networks by competing telecoms providers (like CityFibre, Vodafone and TalkTalk) should in turn encourage BT to upgrade its FTTC network. In fact, BT has already started the roll out of its G.fast network, which is planned to reach 10m premises by 2020.[275] It has also announced it will deliver FTTP to 3m premises by 2020.[276]

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[270] Vodafone response to the March 2017 WLA Consultation, paragraph 9.4.
[271] Vodafone response to the March 2017 WLA Consultation, paragraph 9.4.
[272] CityFibre response to the March 2017 WLA Consultation, paragraph 8.6.21.
[273] https://www.cityfibre.com/news/vodafone-cityfibre-bring-gigabit-speed-fibre-uk/ [accessed 31 January 2018].
[274] https://www.ispreview.co.uk/index.php/2018/02/isp-talktalk-propose-full-fibre-broadband-3-million-uk-premises.html [accessed 17 January 2018].
[275] December 2017 and January 2018, Openreach announced the launch of its G.fast network in various UK cities including Cardiff, Swindon, Sheffield, Newcastle, Glasgow and Edinburgh. See http://news.openreach.co.uk/latest_news [accessed 21 February 2018].
[276] Openreach, Feb 2018, "We're launching our "fibre first programme', https://www.homeandbusiness.openreach.co.uk/news/fibrefirst [accessed 21 February 2018].

Hence, we do not accept Vodafone's argument, that our anchor pricing approach will lead to BT keeping its FTTC technology for longer, is supported by market developments.

A14.18 In summary, we conclude that our anchor pricing approach of basing the GEA 40/10 charge on the costs of an ongoing FTTC overlay network (using VDSL2 technology) protects existing fibre customers from high prices whilst promoting investment in full fibre networks.

Bottom-up cost modelling approach

A14.19 In determining our approach to estimating the costs of an ongoing fibre access overlay network based on an FTTC topology using VDSL2 technology, we need to consider whether to estimate the costs on a top-down or bottom-up basis.

Our proposals

A14.20 In our March consultation, we considered that a bottom-up approach would be appropriate to model the costs of FTTC services. We noted that the AVE/CVEs used in a top-down model to forecast costs are less reliable in the context of significant changes in service volumes. We said that a bottom-up approach would more accurately identify the underlying cost-volume relationships by using network build parameters which mimic the planning rules that operators use in practice.

A14.21 We recognised that bottom-up and top-down models present transparency challenges in that both are likely to rely on BT confidential data, but that we believed that a bottom-up approach would at least offer stakeholders the opportunity to validate the outputs of the model and observe the underlying cost-volume relationships – the derivation of which can be opaque in a top-down model.

Stakeholder responses

A14.22 Virgin Media, TalkTalk and Vodafone responded on this proposal. Virgin Media said we had not "presented compelling arguments to justify the adoption of a bottom-up LRIC+ approach. To the contrary, adjustments such as: shortening the time horizon of the model; the use of CCA depreciation; the use of simplifying assumptions on network technologies and the need for extensive calibration of the model to BT's actual data further weaken the case for the use of bottom-up modelling because they make the bottom-up model more akin to a top-down model".[277] It further argued that our model "provides limited transparency compared with a top-down FAC approach", noting that the fact that stakeholders are familiar with RFS based cost models and they use audited cost data are important advantages in the top-down approach.[278]

[277] Virgin Media response to the March 2017 WLA Consultation, paragraph 142.
[278] Virgin Media response to the March 2017 WLA Consultation, paragraph 144.

A14.23 Virgin Media stated that our choice to use a "bottom-up LRIC+ GEA 40/10 cost standard will result in an even greater patchwork of cost attribution approaches applied across a range of inter-related services". It argued that this is likely to undermine stakeholders' ability to comment meaningfully on the analysis.[279]

A14.24 TalkTalk said that its concerns with adopting a bottom-up approach which were set out in its submission to Ofcom's previous consultation in May 2016 remain unchanged.[280]

A14.25 Vodafone, on the other hand, agreed with our proposal to use a bottom-up approach, for: "more accurate modelling of cost-volume relationships, greater transparency, and consistency with the 2013 Recommendation".[281] Vodafone however was concerned about the degree to which "the model is truly a bottom-up, equally efficient operator based approach and the degree to which BT's costs have simply been modelled", arguing that more than 50% of the costs included in the GEA cost stack are directly sourced from BT.[282]

Our reasoning and decision

A14.26 As previously set out, bottom-up and top-down models have both advantages and disadvantages. Bottom-up models are better at determining the cost-volume relationships used to forecast costs, particularly when volumes are facing significant changes over the modelling period. Top-down models, by contrast, are better at establishing the absolute level of costs as they use real network costs as the starting point of the modelling exercise.

A14.27 In modelling the costs of an efficient FTTC overlay network we have adopted a hybrid approach to make the most of these two approaches. Whilst we have used a bottom-up model to identify the cost-volume relationships and determine how costs change over time, we have used top-down data to calibrate the bottom-up model and set the absolute level of costs for the modelled network. We believe that this hybrid approach is appropriate in this case given that fibre volumes have grown considerably over the last few years and we expect they will continue to do so over the charge control period, albeit at a lower rate. In developing this approach we have taken utmost account of the 2010 EC Recommendation[283] and 2013 EC Recommendation.[284]

A14.28 We consider top-down approaches to be appropriate in some circumstances and, as discussed in Annex 12, we are using a top-down model to inform our charge controls on

[279] Virgin Media response to the March 2017 WLA Consultation, paragraph 145.
[280] TalkTalk argued that a bottom-up model is more likely than a top-down model to lead to allocative inefficiency, since no audited accounting data will be available to inform Ofcom's estimates and other data will be scarce as there are no other FTTC networks in the UK and cross border estimates would not be representative. In addition, TalkTalk believed there is a lack of evidence to support Ofcom's claim that a bottom-up approach provides greater transparency. It argued "there are more likely to be confidentiality issues in the data underlying a [bottom-up] model than a [top-down] one, as the unit costs incurred by BT for various network elements are more likely to be commercially confidential than heavily aggregated total expenditure" in top-down models.
[281] Vodafone response to the March 2017 WLA Consultation, paragraph 9.5.
[282] Vodafone response to the March 2017 WLA Consultation, paragraph 9.6.
[283] *Commission Recommendation of 20 September 2010 on regulated access to Next Generation Access Networks (NGA) (2010/572/EU)*, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010H0572&from=EN.
[284] *Commission Recommendation of 11.9.2013 on consistent non-discrimination obligations and costing methodologies to promote competition and enhance the broadband investment environment (C(2013) 5761).* http://ec.europa.eu/smart-regulation/impact/ia_carried_out/docs/ia_2013/c_2013_5761_en.pdf.

copper services. However, for FTTC services, we do not consider that top-down data can sufficiently inform the relevant cost-volume relationships and so have used a bottom-up approach to assess the impact of changing volumes on the incremental costs of supplying FTTC. Therefore, contrary to TalkTalk's view, expressed in response to our March consultation, we consider that a bottom-up approach is more likely than a top-down approach to lead to higher allocative efficiency in this case.

A14.29 We recognise Virgin Media's concern that using a mix of modelling approaches could lead to cost attribution inconsistencies. However, as discussed in Annex 12, we are using top-down data to determine the total market level costs and to allocate common costs between fibre and copper services. By allocating common costs in this way, we ensure there is not an inconsistent cost allocation between services modelled using different approaches.

A14.30 We discuss the sources of information we have used to populate and calibrate the bottom-up model in paragraphs A14.77 to A14.79.

Scorched node approach

A14.31 In using a bottom-up approach, we need to determine whether to model a completely hypothetical fibre access network with the most efficient (lowest cost) design and topology (a scorched earth approach), or to use the deployment of existing infrastructure as a starting point for any modelling exercise (a scorched node approach).

Our proposals

A14.32 In our March consultation we proposed to use a scorched node approach[285] and to align the number and location of key civil infrastructure elements with the FTTC network deployed by Openreach. We said that, unless we find evidence suggesting that Openreach made inefficient network design choices, based on the information available at that time, we would seek to mirror its FTTC network rollout.

Stakeholder responses

A14.33 TalkTalk and Vodafone commented on our proposal to use a scorched node approach. TalkTalk agreed with our proposed approach stating that a scorched node approach "is appropriate when a bottom-up modelling approach is being used".[286]

A14.34 Vodafone also agreed and said that a "scorched node approach to bottom up modelling has practical benefits". However, it noted that "the current network topology deployed by [Openreach] for its FTTC services is heavily influenced by the legacy left by its copper-based origins" and that "an efficient network topology would feature far fewer optical nodes, and be less costly overall". It also noted that "[Openreach] plans to change its network topology fundamentally in that direction over the medium term (within the timescale

[285] This was also our proposal in the May 2016 WLA Consultation. We addressed responses to the May 2016 consultation in the March 2017 WLA Consultation so do not repeat these here.

[286] TalkTalk response to the March 2017 WLA Consultation, paragraph 7.22.

considered by the model), vacating most of its exchanges". Consequently, Vodafone concluded that "applying the scorched node approach to [Openreach]'s current network topology inflates costs above not only efficient greenfield levels, but also above [Openreach]'s own likely level of costs in the medium to longer term".[287]

Our reasoning and decisions

A14.35 We remain of the view that whilst Openreach might build its FTTC network differently if it was planned now, this does not mean that we should ignore its historical network design decisions. Openreach's existing copper network is the outcome of the accumulation of decisions it has made over time and it would be inappropriate for us to ignore these decisions for the purposes of modelling an FTTC overlay network.

A14.36 These decisions include determining how to connect cabinets back to exchanges as part of the FTTC rollout. Whilst BT has re-used existing civil infrastructure to provide these connections where possible, it has not used all of the existing local exchanges (i.e. all child exchanges) in its FTTC build but only a subset of them (the parents). We have followed this approach, which implies that the majority of Openreach's local exchanges[288] do not have optical equipment in them, in the model we have developed. So, in effect, the scorched node approach already anticipates that a lower number of local exchanges are used in deploying a FTTC network, as suggested by Vodafone.

A14.37 Therefore, in the absence of evidence suggesting that Openreach has made inefficient network design choices, based on the information available at the time these choices were made, we have based our modelling on Openreach's current network topology.

NGA network dimensions and geographic coverage

Our proposals

A14.38 In our March consultation we proposed to model the costs of a national efficient FTTC access operator. We said that we would expect an efficient operator to roll out in areas which are profitable to serve. As such, we proposed to base the bottom-up model on commercial FTTC areas, excluding all areas where FTTC deployment costs have been subsidised (in part or in whole) by government and other public funding, e.g. BDUK.

A14.39 We said that excluding the costs, volumes and revenues associated with subsidised rollout from our modelling was likely to best mirror the costs of an efficient commercial network operator in the least complex manner. We explained that including subsidised areas would require us to consider how to treat the subsidies Openreach has received, which would be complex and potentially problematic given the number of contracts involved and the clawback mechanism embedded in them.

[287] Vodafone response to the March 2017 WLA Consultation, paragraph 9.8.
[288] Of the 5,571 local exchanges in BT's network (see Annex 8 of the June 2017 WBA Consultation), around [✂] have optical equipment – Openreach response to question 1.1 of the 38th s.135 notice dated 18 September 2017.

A14.40 We stressed that we would be concerned if this approach would not allow Openreach the opportunity to recover its efficiently incurred costs in subsidised areas. As a cross-check for cost recovery, we compared BT's unit FAC (as per the 2015/16 RFS) between commercial and non-commercial areas. We found that the average unit cost (net of government funding) was broadly similar in the two areas, implying no cost recovery problem if we set prices in subsidised areas on the basis of costs in the commercial area.

A14.41 We also investigated whether our approach could lead to Openreach over-recovering its costs because of higher than expected fibre take-up in subsidised areas. A higher than expected take-up would have the effect of pushing unit costs down in these areas and thus create a unit cost gap between the commercial and subsidised areas. We concluded that such risk was limited given that Openreach would have to give any excess profits resulting from higher than expected take-up back to the government as part of the claw-back provisions in the BDUK contracts.

Stakeholder responses

A14.42 Openreach considered that our focus on commercial areas was mistaken due to the [✂].[289]

A14.43 TalkTalk on the other hand agreed with our proposed approach. It stated that "it is correct to adopt the assumption that, post-subsidy, [Openreach]'s unit costs in BDUK-subsidised areas should be similar to [Openreach]'s unit costs in purely commercial areas, as demonstrated by Ofcom's accounting analysis".[290]

A14.44 Vodafone acknowledged the advantages of limiting the network model and the difficulties in obtaining data that would make the inclusion of a wider range of geographic network possible. However, it raised the concern that it "is possible that Ofcom's cost model includes costs that are already funded by government subsidies" and that "including these costs would allow [Openreach] to double recover".[291] As an example of this, Vodafone referred to the BDUK procedure document which includes software and system development costs as permitted costs under the BDUK funding contract. Vodafone argued that "costs associated with [OSS/BSS] systems could be wholly included in Ofcom's model and yet also be covered in part by the BDUK subsidy".[292]

Our reasoning and decision

A14.45 We have updated our analysis on the difference in FAC between the commercial and subsidised areas using 2016/17 RFS information and have found a similar result, with the unit FAC difference between the two areas reducing to less than 1%.[293] Therefore, we remain of the view that unit costs across commercial and subsidised areas are broadly similar, and that excluding the costs, volumes and revenues associated with Openreach's

[289] Openreach, 2017, [✂] submitted in response to question 7b of the 1st s.135 notice dated 18 December 2015. BT CONFIDENTIAL].
[290] TalkTalk response to the March 2017 WLA Consultation, paragraph 7.24.
[291] Vodafone response to the March 2017 WLA Consultation, paragraph 10.2.
[292] Vodafone response to the March 2017 WLA Consultation, paragraph 10.3.
[293] When using the 2015/16 RFS data we found a difference of 2%.

subsidised rollout from our bottom-up modelling would not lead to a cost recovery problem.

A14.46 This approach also has the benefit of avoiding the complexity of analysing c.50 BDUK contracts and estimating the amount of claw-backs each contract could face over the model's time horizon in order to estimate the net cost to Openreach of supplying FTTC services in subsidised areas.

A14.47 We do however acknowledge Vodafone's concern regarding the risk of including BDUK specific costs in our analysis of Openreach's FTTC commercial costs. To mitigate this risk, as we did in our March consultation, we have scrutinised Openreach's cost information. For example, we have compared the cost data provided across different BT/Openreach data sources to verify its robustness. As a result of this process we have removed [✂] (~£17m) of BDUK-related OSS/BSS costs, as explained below. This analysis coupled, with our cost recovery analysis, satisfies us that we are including the right level of costs in our model for Openreach's commercial deployment.

A14.48 We therefore have decided to only include costs associated with non-subsidised areas in the bottom-up model.

Span of network in scope

A14.49 In the March consultation we proposed modelling the portion of the FTTC network up to the point of handover i.e. the point where access is made available to other telecom providers.[294] We have continued to use this modelling approach when producing our final cost estimates.

A14.50 We have decided to exclude customer modems from the scope of the modelled network. As noted in our March consultation, this is because Openreach no longer provides this equipment to downstream providers and the customer modem costs that Openreach has incur in the past have already been recovered.

Assessment duration

A14.51 We proposed to reduce our modelling duration from 2007/08 to 2028/29 in the March consultation. We considered that the 40-year time horizon we had proposed in May 2016 was no longer needed as we were not proposing to use economic depreciation.

A14.52 Only TalkTalk commented on our proposed assessment duration, saying that it agreed with our proposal to shorten the modelling duration from 2047/48 to 2028/29. It argued that "a shorter modelling period provides for more certainty over the results of the model, and of the assumptions used to generate the model".[295]

A14.53 We have therefore decided to reduce our modelling duration further, from 2007/08 to 2028/29. We use the data from 2018/19 to 2020/21 for the purposes of setting our charge

[294] No stakeholder provided responses to our consultation on this matter.
[295] TalkTalk response to the March 2017 WLA Consultation, paragraph 7.26.

controls and undertake some cross checks as part of our analysis for years beyond the charge control.

Fibre services in scope

A14.54 In the March consultation we proposed modelling the costs of GEA services, including rental and ancillary services. We clarified that SOGEA[296] was not part of the services in scope, as it is a product that was not in the market yet (except for in trials) and the extent to which it could be taken up by telecoms providers was still unknown. We said that we would continue to monitor markets and that in the event that SOGEA gets launched we would reconsider our approach where appropriate.

A14.55 Following the March consultation, we have requested further information from telecoms providers on their intended use of a SOGEA service over the period of the charge control and we understand that there is interest in taking up this service during this time period.

A14.56 This is despite Openreach not yet providing information on the price at which it plans to offer this service. However, for telecom providers to consider SOGEA attractive, the price is likely to be constrained by the controlled MPF + GEA 40/10 price. So, for the period of this review, even if there is take-up of SOGEA we do not expect this take-up to become so significant that the MPF and GEA 40/10 charge controls would not provide a constraint on SOGEA's pricing.

A14.57 For this reason, we have decided not to include SOGEA in our cost modelling, and to continue to monitor markets to ensure that our charge controls decisions remain effective over the review period.

Shared infrastructure

A14.58 We consulted in March 2017 on an approach that meant any costs which are not incremental to the provision of FTTC services would be excluded from the bottom-up model.[297]

A14.59 We also consulted on an approach that meant common costs which are shared between fibre and copper services would be allocated through a separate top-down assessment. Annex 12 sets out our methodology for allocating these common costs across fibre and copper services (and sets out and considers the views of stakeholders as appropriate).

A14.60 We recognise that shared costs could also arise between WLA and non-WLA fibre services (e.g. leased lines). Not accounting for such shared assets could lead to us under- or over-estimating the LRIC of supplying fibre services as well as under- or over-compensating BT. We proposed to address this issue by:

a) assuming that the modelled network reuses fibre cables in a portion of the backhaul routes (see Annex 29);

[296] Single order GEA (i.e. a service that would allow telecoms providers to offer both broadband and voice services).
[297] No stakeholder provided responses to our consultation on this matter.

b) allowing BT to recover attributed costs (as per BT's RFS) rather than fully incremental costs in relation to duct assets; and

c) calibrating the bottom-up model against BT's top-down costs to ensure that our cost modelling does not result in a cost recovery problem.

A14.61 No stakeholder responded on this issue and we have decided to use the above approach to produce our final cost estimates.

Depreciation method

A14.62 Once the total costs of the fibre access network have been calculated, we have to determine how these costs are to be recovered over time.

Our proposals

A14.63 In our March consultation we considered the following depreciation methods:

a) Economic Depreciation (ED); which may be:

i) Original Economic Depreciation (Original ED); or

ii) Simplified Economic Depreciation (Simplified ED); and

b) Current Cost Accounting (CCA).

A14.64 We said that although economic depreciation has some theoretical advantages, CCA depreciation would provide more stable results in this case. We explained this was because the uncertainty around the impact of our DPA policy and Virgin Media's Lightning programme was likely to be modest over the review period, and thus our volume forecasts were likely to be fairly stable in the medium term, but less so beyond 2020/21.[298]

A14.65 We considered that CCA depreciation would be also consistent with the way we assess copper costs in this charge control. We noted that this had the advantage of allowing a more coherent approach for analysing common costs which are shared between copper and fibre services.

A14.66 We therefore proposed to use CCA depreciation to determine the appropriate cost recovery path in the bottom-up model.

Stakeholder responses

A14.67 Only Vodafone commented on our proposed approach. It said that it did not "fully understand Ofcom's explanation of their rationale for using CCA depreciation in the bottom-up model", arguing that "in the past Ofcom have used economic depreciation

[298] In our March consultation we explained that the use of economic depreciation entails forecasting costs over a long time period (in this case 40 years). Given the sensitivity of the model outputs to service volumes, we stressed that the uncertainty around the impact of DPA and Project Lightning on our long-term volume forecasts would affect the reliability of the results of economic depreciation.

when building bottom up models, and that this ensures the profile of cost recovery is consistent with the path of prices which would occur in a competitive market".[299]

A14.68 Vodafone also expressed its concerns "that CCA depreciation methods can lead to volatility due to fluctuations in asset values and in-life asset replacements".[300] It also asked if we "have considered whether BT will over-recover their costs in later years" as BT has a history of using assets for far longer than their accounting lives.[301]

Our reasoning and decision

A14.69 In our March consultation we acknowledged that in the past we have chosen to use economic depreciation when building a bottom-up model. This was the case for our Mobile Call Termination (MCT) models since 2005,[302] the 2013 Narrowband Network Charge Control (NCC) model[303] and the 2017 Wholesale Call Termination (WCT) model.[304] However, in these instances we did not combine the use of top-down and a bottom-up models to determine our charge controls as we are doing in this review. Therefore, the issue of having a consistent depreciation method for reallocating common costs across the charged controlled services had not come up in the past.

A14.70 We consider that this consistency issue, together with the uncertainty around our service volume forecasts for the period beyond this charge control, warrant the use of a different approach in this review (namely using CCA depreciation). Not doing so would result in inconsistent unit LRIC+ estimates for copper and fibre services, as the analysis of common costs shared between fibre and copper services would be done using costs estimated using different depreciation approaches.

A14.71 We have also investigated Vodafone's concern about the use of CCA leading to price volatility. Specifically, we have looked at the trajectory of the service unit costs produced by the bottom-up model beyond the charge control period. This trajectory shows no significant step changes in the forecasted GEA charge rental. However, and as proposed in our March consultation, if future charge controls are deemed appropriate and our cost modelling leads to significant variation in access prices, we would consider spreading such price variation over a number of years.

A14.72 Finally, to Vodafone's question of whether we have considered if BT may over recover its costs as a result of our charge control decisions, we stress that we have used the available evidence to inform the likely costs of an efficient FTTC overlay operator. We consider that we have made an unbiased estimate of these costs and that there is the risk for BT of both over and under-recovery. This risk is independent of our choice of depreciation method as it may also arise with the use of economic depreciation. We have mitigated this risk by

[299] Vodafone response to the March 2017 WLA Consultation, paragraph 13.6.
[300] Vodafone response to the March 2017 WLA Consultation, paragraph 13.7.
[301] Vodafone response to the March 2017 WLA Consultation, paragraph 13.8.
[302] See https://www.ofcom.org.uk/consultations-and-statements/category-1/mobile-call-termination-14.
[303] See https://www.ofcom.org.uk/consultations-and-statements/category-2/nmr-13.
[304] See https://www.ofcom.org.uk/consultations-and-statements/category-1/narrowband-market-review.

calibrating our model outputs against various BT/Openreach sources as further explained in Annex 15.

A14.73 We therefore have decided to use CCA depreciation within the bottom-up model.

Service costing

A14.74 Once we have determined how the costs of a particular network element should be recovered over time, we need to calculate how these costs will be recovered across services.

A14.75 We proposed in our March consultation that the costs recovered by a particular service should be linked to the costs that are driven by that service. Each service has a routing factor that determines the amount of a particular piece of network equipment that a service uses, and we proposed that these routing factors should be used to allocate asset costs to services. No stakeholder commented on this approach and we have decided to use this modelling approach to produce our final estimates.

Data sources and key modelling assumptions

A14.76 In the remainder of this section we discuss the data sources and our key modelling assumptions we use in our bottom-up model.

Data sources

Our proposals

A14.77 In our March consultation we explained that we had primarily relied on BT and Openreach data, alongside our own (and Cartesian's) understanding of how networks are built, to inform the assumptions in the bottom-up model.

A14.78 The BT and Openreach data sources we proposed to use are:

- BT's actual asset count;
- BT's Management Accounts;
- BT's RFS; and
- BT's Chief Engineer's Model (the 'Openreach Model').

Stakeholder responses

A14.79 In its response to our consultation, Openreach noted that the design of our charge control modelling should be revised and include the costs in the Openreach business case which are £0.5bn higher than assumed in Ofcom's model. Alongside its response to our March consultation, Openreach provided us with its latest NGA business case which we discuss in further detail as part of the key modelling assumptions sub-section below.

A14.80 Vodafone argued that "Ofcom's modelling methodology whereby the network design, network costs, and various additional and overhead costs are sourced and based almost exclusively on BT's costing data means the risk that the calculated result includes significant errors is extremely high and asymmetric".[305]

A14.81 It stated that "in the case of a fibre FTTC bottom-up model it would seem that there would be various sources of actual data and models that could be referenced and benchmarked against".[306] As examples, Vodafone mentioned i) other operators that have rolled out actual networks in the UK, ii) BT business plans in connection with the BDUK government funding schemes, iii) business plans of other operators, and iv) networks that have been rolled out in countries with similar geographic characteristics as the UK.

A14.82 In addition, Vodafone said that it would like to understand "how [the various data sources used to populate the model] have been audited and reconciled to the regulatory and statutory accounts".[307] It stated that "in the case of the RFS data this is understood, however with regards to BT actual asset count data, BT's management accounts, and BT's chief engineers model, it is not clear".

Our reasoning and decisions

A14.83 As explained in paragraph A14.18, our aim is to model the costs of an efficient FTTC overlay network. In doing so, we are interested in both:

a) protecting existing fibre customers from high prices, and

b) allowing BT the opportunity to recover its efficiently incurred costs.

A14.84 We have already set out that we consider this could be best achieved by mirroring the geographic scope of BT's FTTC commercial deployment while excluding revenues, volumes and costs in areas where BT has received some kind of government funding.

A14.85 To inform this modelling exercise we consider that BT's costs are most relevant. In particular, we have decided to use the following sources of information, gathered under our formal powers:

a) BT's actual asset count: BT provided information on the number of network elements operating in its FTTC network within commercial areas. This information was supplied for elements such as FTTC cabinets, DSLAM variants, FTTC enabled exchanges, aggregation nodes, track joints and junction boxes.[308] For most of these elements, the data were provided as of August 2017, but for FTTC cabinets and exchanges enablement dates were provided, allowing us to identify the timing of BT's actual network rollout.

[305] Vodafone response to the March 2017 WLA Consultation, paragraph 12.3.
[306] Vodafone response to the March 2017 WLA Consultation, paragraph 12.3.
[307] Vodafone response to the March 2017 WLA Consultation, paragraph 12.5.
[308] Openreach response dated 6 September 2016 to questions 1 and 5 of the 14th s.135 notice; Openreach response to questions 2, 3 and 7 of the 11th s.135 notice dated 25 July 2016; Openreach response dated 13 January 2017 to question 10 of the 23rd s.135 notice; and Openreach response to questions 2.3, 3.1, 3.2 and 3.3 of the 38th s.135 notice dated 19 September 2017.

b) BT's Management Accounts: BT provided information on its GEA specific capital and operating spend on Operational and Business Support Systems (OSS/BSS) for the period from 2010/11 to 2016/17;[309] and information on GEA specific pre-service launch costs for the period from 2008/09 to 2016/17.[310] It also supplied information on the asset lives used to book its GEA capital spend against for a number of network assets.[311]

c) BT's RFS: BT provided information on the costs it allocates to commercial GEA services, on a LRIC and FAC basis. This information was provided at a component level and for the years 2014/15, 2015/16, and 2016/17.[312]

d) Openreach Model: This is a bespoke model used by Openreach for strategic and budgeting purposes.[313] It uses a bottom-up approach to dimension the network elements necessary for deploying a fibre network and calculates the corresponding costs. While Openreach did not provide the Openreach Model itself, it supplied the network and cost assumptions underpinning it. Specifically, Openreach provided the assumptions used in various versions of the Openreach Model over the period from March 2009 to March 2016.[314] After our March consultation, these assumptions were updated to August 2017.[315]

e) Openreach NGA business cases: Openreach provided its most recent NGA business cases setting out the actual and planned capital and operational expenditure over the period 2008/09 to 2028/29 for its NGA1 and Fibre First programmes.[316]

f) 2016 Connected Nations report: to validate some of the cost forecasts in the Openreach business cases we have used take-up data at the cabinet level submitted by Openreach for our 2016 Connected Nations report.

A14.86 With regards to information from other operators in the UK, they either do not have a network that is comparable in size to and/or technology used by the modelled network. While there could be more similar networks in other countries, their underlying costs are unlikely to be comparable to the modelled network's as important cost drivers, such as geography and demographics, which tend to vary across countries. Nonetheless, we have

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[309] Openreach response dated 4 July 2016 to question 7 of the 8th s.135 notice; Openreach response dated 20 September 2016 to question 9 of the 14th s.135 notice; and Openreach response to question 2.6 of the 38th s.135 notice dated 19 September 2017.
[310] Openreach response dated 13 June 2016 to question 15a of the 16th s.135 notice.
[311] Openreach response dated 6 September 2016 to question 3 of the 8th s.135 notice; and Openreach response to question 2.10 of the 38th s.135 notice dated 19 September 2017.
[312] Openreach response dated 25 November 2016 to questions 3 and 6 of the 19th s.135 notice; and BT's response to the 34th s.135 notice dated 16 August 2017.
[313] Meeting between Ofcom and BT staff on 13 May 2016.
[314] Openreach response dated 6 September 2016 to questions 1 and 2 of the 14th s.135 notice.
[315] Openreach response to questions 2.1, 2.2 and 2.4 of the 38th s.135 notice dated 19 September 2017.
[316] Openreach submitted its updated NGA1 business case alongside its response to our March consultation. It has also provided relevant information in response to the 36th, 42nd and 45th s.135 notices dated 18 September 2017, 7 December 2017 and 9 January 2018 respectively. Openreach also submitted its most recent Fibre First business case in response to our 47th s.135 noticed dated 6 February 2018.

compared our final unit cost estimates against the charges set by other European NRAs as a cross-check. We discuss this cross-check in Annex 15.

A14.87 In addition, as part of the process of populating the bottom-up model, we have sought information from a number of telecom providers[317] who are likely to have costs related to deploying fibre access networks. Since our March consultation we have collated further information from some telecom providers.[318] However, the information that we received was either indicative (as it was used for planning purposes and/or trials) or not representative of the costs of a FTTC network at scale. We have therefore used this information to cross-check the cost data we have received from BT where appropriate, but have not used it to directly inform the input values used in the bottom-up model.

A14.88 We understand that Vodafone's concern is that BT may have incentives to inflate the costs in the charge control and provide information accordingly. We have mitigated this risk by:

i) looking at various BT/Openreach sources to identify possible inconsistencies across the data. In particular, we believe that the information from the Openreach Model is less subject to gaming as it was not built for regulatory purposes;

ii) validating the cost forecasts in the Openreach business cases using take-up data at the cabinet level from the 2016 Connected Nations report;

iii) cross-checking the model inputs against the information received from telecoms providers, as noted above, where appropriate;

iv) calibrating the bottom-up model against audited accounting data; and

v) cross-checking the model outputs against international benchmarks.

A14.89 In various instances we have identified discrepancies across the different BT/Openreach data sources. We outline and address these discrepancies in Annex 15.

Key assumptions in the bottom-up model

A14.90 In this subsection we explain the following key assumptions in the bottom-up model in turn:

- Costs associated with deploying vectoring;
- Asset lives of DSLAMs;
- In life capacity growth;
- Power costs;
- Maintenance costs;
- OSS/BSS costs;
- Customer installation costs;
- Cumulo;
- Repair costs;

[317] We gathered information from Virgin Media, Vodafone, KCOM, TalkTalk and Sky using our statutory information gathering powers.
[318] CityFibre and Virgin Media.

- SLG payments;
- General management costs;
- E-side and Remote duct costs;
- Openreach's Fibre First programme;
- New sites; and
- Cost of capital.

Vectoring and transformation costs

Our proposals

A14.91 In our March consultation the basic architecture of the FTTC deployment in our model included a DSLAM housed in an FTTC cabinet in the street. The DSLAM connected back to an Optical Line Termination (OLT – also known as the head end) in the parent exchange via an Optical Consolidation Rack (OCR). The connection was a 1Gb/s ethernet (1GE) connection over fibre.

A14.92 We also proposed replicating BT's dual vendor strategy (i.e. BT uses two vendors for sourcing its FTTC equipment: Huawei and ECI). To implement this strategy, we took average costs and average equipment capacities based on the share each vendor has of the total number of equipment operating in BT's commercial network.

Stakeholder responses

A14.93 In response to our March consultation, Openreach argued we had omitted a number of costs from our cost modelling.[319] It said that we were missing the costs of:

a) Deployment of vectoring;

b) [✂] (DSLAM upgrade to support line growth) which we refer to as the 'transformation programme'; and

c) Upgraded headends and 10 gigabit ethernet (GE) connections.

A14.94 As a follow-up to its response, Openreach clarified that the deployment of vectoring was necessary in order to support the demand for future FTTC services, as higher than expected fibre take-up meant that speeds over its FTTC network would degrade over time due to increasing cross-talk[320] across lines. Openreach also argued that new equipment was required to enable the use of 10GE backhaul cards and higher-density line cards.[321]

[319] Openreach response to our March 2017 WLA Consultation- Volume 2, paragraph 256.
[320] Cross-talk is a type of signal interference caused when a signal on one transmission bearer or channel interferes with the signal on another transmission bearer or channel. Cross-talk typically occurs as a result of multiple copper access lines being in close proximity, as in the case of a copper cable containing a number of telephone lines. This can result in voice or broadband data signals on the lines in a cable interfering with one another.
[321] BT presentation to Ofcom on 19 July 2017, "Openreach fibre business case – June 2017 update"; and Openreach response to question 2 of the 36th s.135 notice dated 18 September 2017.

A14.95 Openreach explained that part of the vectoring deployment involves [✂] (a transformation programme to replace older and less capable DSLAM equipment with newer equipment where vectoring is to be deployed). [✂].[322]

A14.96 Openreach further explained that the transformation programme [✂] (would require upgrades of DSLAM chassis), air handling equipment, power unit distribution, line cards and headends [✂] (within some exchange areas). It clarified that most civils would be retained except for the outer shell of the FTTC cabinet.[323]

A14.97 [✂] (Openreach also clarified that in areas not affected by the transformation programme, the deployment of vectoring would only require the upgrade of the DSLAM chassis and line cards.[324])

Our reasoning and decisions

A14.98 Consistent with our anchor pricing approach, our modelling seeks to determine the costs of an efficient operator of an ongoing FTTC network, where all its fibre customers are supported on that FTTC network. It differs from Openreach because Openreach is also deploying G.fast and FTTP networks. Therefore, whilst the network architecture and cost data are sourced from BT, we need to consider whether costs that may be incurred by BT would be incurred by a hypothetical efficient FTTC operator.

A14.99 We consider vectoring, transformation programme and headend/10GE costs on this basis below.

Vectoring

A14.100 Based on Openreach's rollout, in the model that we used for the March consultation, we assumed deployment starting in 2008/09. At this time, take-up was uncertain and vectoring technology was still in development. Therefore, an operator commencing rollout of an FTTC network would not have deployed vectoring in its initial rollout.

A14.101 However, demand has increased beyond the initial assumptions made by Openreach, and is expected to continue to grow. This means that operators now have incentives to implement vectoring as, in the absence of vectoring, interference between voice or broadband data signals (sometimes referred to as 'crosstalk') would likely increase, impacting the quality of service provided to consumers. We also note that vectoring is now more widely available.

A14.102 We therefore consider it would be reasonable for an operator to deploy vectoring upgrades across its network and we have therefore decided to allow for the efficient costs of vectoring in our modelling.

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[322] Openreach presentation to Ofcom on 19 July 2017, "Openreach fibre business case – June 2017 update"; Openreach response dated 18 September 2017 to questions 2 and 3 of the 36th s.135 notice; and Openreach response dated 7 December 2017 to question 1 of the 42nd s.135 notice.

[323] Openreach response dated 18 September 2017 to question 2 of the 36th s.135 notice and Openreach email sent to Ofcom on 8 December 2017 clarifying its response to question 2b of the 36th s.135 notice.

[324] Openreach response dated 18 September 2017 to question 2 of the 36th s.135 notice.

Transformation programme

A14.103 Openreach has used two equipment suppliers, Huawei and ECI, to roll out its FTTC network. Openreach has now identified a need to replace [✂] (selected equipment across both of these footprints). There appear to be several drivers for this:

a) [✂] (Support for) vectoring;

b) [✂] (Support for) higher density cards; and,

c) [✂] (Support for) 10GE backhaul.

A14.104 As discussed above, the deployment of vectoring has become necessary in order to remove/reduce the impact of crosstalk from increasing take-up of FTTC based services. Since [✂] (the selected equipment) does not support vectoring, replacing [✂] (the selected equipment with equipment) that can provide vectoring appears to be reasonable.

A14.105 The lack of support for high density cards also suggests replacing [✂] (the selected equipment) is reasonable. High density cards mean more customers can be supported on a DSLAM (because more customer lines can be connected to each line card in the DSLAM). Without this, given the growth in the number of customers, additional DSLAMs (including additional civil infrastructure such as cabinet plinth and additional power equipment) would be required.

A14.106 We have considered whether using [✂] (the selected equipment) was an efficient choice given it now needs to be replaced. As set out previously, we consider that Openreach's decisions should not be judged based on the information we know now but on what was known at the time when the decisions were made. When Openreach started rollout in 2009, FTTC was a nascent technology and, as mentioned above, vectoring was still in development. At that time, it was therefore not evident that [✂] (the selected equipment) was not going to support future technological developments over FTTC. As such, it is not apparent to us that Openreach made an inefficient decision in using [✂] (the selected equipment).

A14.107 On the basis of the need for vectoring, the use of high density cards being an efficient technology choice (compared to adding second cabinets) and the fact that using [✂] (the selected equipment] was not inefficient in the first place, we consider it appropriate to include the costs associated with the transformation programme in the bottom-up model.

Upgraded headends and 10GE connections

A14.108 Openreach stated that costs should be included for upgraded/new headends and to allow for 10GE connections to the DSLAMs.

A14.109 Our forecast of demand for the period of the charge control to 2020/21 does not require 10GE backhaul from the DSLAMs. Based on our forecast, this level of demand does not occur until at least 2023/24 (though we accept that we model volumes based on averages, so cabinets that are particularly large or heavily loaded may see such demand earlier).[325]

A14.110 Therefore, we do not consider that traffic demand alone drives the need for an upgrade to 10GE across the network. Without demand for 10GE, we do not consider that an upgrade of the headends would be necessary.

A14.111 However, there are other reasons why an upgrade may be necessary:

a) [✂] (replacement of selected equipment as part of the transformation programme); and/or

b) other deployments by Openreach.

A14.112 The replacement of [✂] [selected equipment as part of the transformation programme] is discussed above. Because the DSLAM and headend need to be compatible, this suggests the cost of replacing headends serving [✂] (the selected equipment) should also be allowed. However, we do not agree that it should be assumed that these headends would be higher specified and/or that 10GE would be deployed, because, as discussed above, our traffic forecasts do not require this.

A14.113 Another reason to deploy upgraded headends is Openreach's NGA2 programme (i.e. its G.fast and FTTP deployments). We accept that higher specification headends and the use of 10GE backhaul may be appropriate for these deployments. Further, it may be appropriate for Openreach to upgrade its FTTC estate to 10GE and to use its upgraded headends for FTTC as well as G.fast and FTTP. These may be efficient decisions for an operator providing this range of services.

A14.114 However, our charge control models Openreach's network as if only FTTC is deployed. As such, the costs should reflect those needed to run an efficient FTTC network and should not include any additional costs incurred due to Openreach's NGA2 programme.

A14.115 Therefore, in relation to headend and 10GE costs, we consider that:

a) new headend costs should be allowed to the extent these are needed to support the transformation programme;

b) costs related to upgrading/providing 10GE across Openreach's FTTC deployment should not be allowed; and

c) costs to upgrade headends and/or provide 10GE as part of Openreach's NGA2 costs, or to upgrade FTTC so it can share the NGA2 deployment, should not be allowed.

A14.116 In the subsection below, we set out the additional headend costs included in our bottom-up model that arise from general network growth.

Our current modelling approach

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[325] We have analysed fibre take-up data at a cabinet level as of mid-2016. Based on this data and the peak bandwidth and fibre take-up forecasts in the bottom-up model we estimate that the number of cabinets requiring 10GE would be 18 in 2016/17, 206 in 2020/21 and 3,128 in 2023/24. We consider that a cabinet requires 10GE when a third GE card is required in order to meet the estimated peak bandwidth demand at the cabinet.

A14.117 In the next section we explain our decision to align the asset lives we assume for DSLAM assets in the bottom-up model with the evidence from the Openreach NGA business case. This means that our modelling now assumes that DSLAMs in the modelled network will start to get replaced at the same time as Openreach plans to deploy vectoring and carry out the transformation programme on its FTTC network.

A14.118 We have assessed whether this would be sufficient to capture all vectoring and transformation costs. For this purpose, we have compared our model outputs against the vectoring/transformation costs in the Openreach NGA business case, after excluding the costs to upgrade headends and/or provide 10GE connections (in consistency with our reasoning set out above).

A14.119 In doing so we have assessed the reasonableness of Openreach's vectoring/transformation cost forecasts. Specifically, we have interrogated the volumetric and unit cost assumptions underpinning Openreach's figures, by comparing these against the assumptions in the Openreach Model and in our bottom-up model. As part of this process, Openreach made the following corrections/updates to the assumptions used in its NGA business case:

- following a more detailed cost analysis carried out by Openreach in September 2017,[326] the cost of re-shelling the FTTC cabinet (where [✂] (selected equipment as part of the transformation programme) gets replaced) was reduced from [✂] (£2,000 – £3,000) to [✂] (£500 – £1,000);[327]
- Openreach corrected the unit cost of adding a vector engine to vector-ready DSLAMs [✂] from [✂](£10,000 – £15,000) to [✂] (£1,000 – £2,000).[328]

A14.120 Openreach also clarified that within its vectoring/transformation cost estimates [✂] development costs were included for architecture and solution studies, network design, systems design and development, component testing and end to end integration of networks, systems and processes, amongst other costs.[329] Openreach confirmed that these costs include development costs associated with the introduction of 10GE connections and headend upgrades.[330] Openreach was not able to provide a cost split for these costs.[331] However, based on the share that 10GE connections and headend upgrades have of the total vectoring/transformation costs, we estimate that around 15% of the total development costs are 10GE and headend related.

A14.121 We have made adjustments to the vectoring/transformation costs in the Openreach NGA business case to reflect the corrections, updates and clarifications above. Figure A14.1 illustrates the materiality of these adjustments, which include the exclusion of headend and 10GE backhaul costs, over the period 2017/18 to 2022/23.

[326] Openreach response to question 2a of the 36th s.135 notice dated 18 September 2017.
[327] Openreach response of 8 December 2017 clarifying Openreach's response to question 2b of the 36th s.135 notice.
[328] Openreach response dated 7 December 2017 to questions 10e of the 42nd s.135 notice.
[329] Openreach response to question 22b of the 45th s.135 notice dated 9 January 2017.
[330] Openreach response to question 22b of the 45th s.135 notice dated 9 January 2017.
[331] Openreach response to question 22b of the 45th s.135 notice dated 9 January 2019.

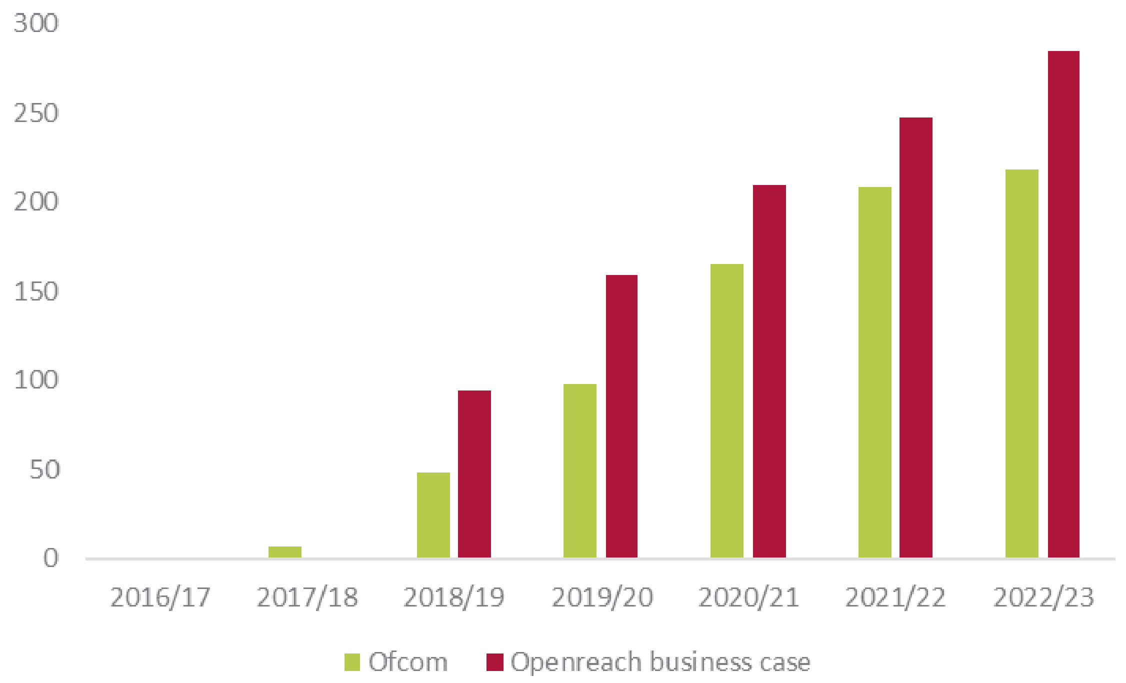
Figure A14.1: Adjustments made to the vectoring/transformation costs in the Openreach business case (commercial only) over the period 2017/18 to 2022/21 - £m [✂]

Source: Ofcom analysis of Openreach information[332]

A14.122 The figure below compares our unadjusted model outputs against the adjusted Openreach cost forecasts. It shows that our modelling understates Openreach's cost forecasts by 15% to 20% by the end of the review period. The gap is mainly explained by non-electronic related costs incurred in relation to the transformation programme such as cabinet shell, power distribution unit, cable rearrangement and [✂] (selected equipment) card disposal costs. As discussed above, we believe that an efficient operator would incur these costs.

A14.123 Note that these additional costs are not incurred when deploying vectoring in areas not affected by the transformation programme.

Figure A14.2: Cumulative incremental capex for DSLAM elements – £m



Source: Ofcom analysis of Openreach information[333]

Options to capture additional costs from transformation programme

A14.124 To remedy the capex shortfall in the bottom-up model we have considered the following three options:

i) Reducing the life assumed for DSLAM assets to allow for faster depreciation;

ii) Adjusting the prices of DSLAM assets to capture additional costs; and

[332] Openreach response to questions 11 and 15 of the 36th s.135 notice dated 18 September 2018 and Openreach response to question 13 of the 42th s.135 notice dated 7 December 2017.
[333] Openreach response to questions 11 and 15 of the 36th s.135 notice dated 18 September 2018.

iii) Explicitly modelling the additional vectoring costs in the bottom-up model by further disaggregating the network elements included in our modelling.

A14.125 The first option is simple to implement but would imply assuming an asset life that is shorter than the expected economic life of a DSLAM (as discussed in the next subsection). This would have the effect of distorting the calculation of the unit LRIC, particularly in the years prior to the deployment of vectoring.

A14.126 This is not to say that assuming a shorter asset life would not be appropriate in other circumstances. This could be a reasonable modelling simplification where the costs introduced by a new technology are unavailable or are highly uncertain. However, as described above, we have received detailed information from Openreach on the costs of vectoring and transformation and thus we believe that using a shorter asset life would be inappropriate in this case.

A14.127 The second and third options would use the NGA business case cost forecasts and assumptions to replicate the costs introduced by vectoring. The key difference between these two options is the level of detail at which vectoring costs would be modelled. While the second option entails uplifting the price of the modelled assets to match the additional costs, the third option requires adding more cost granularity to the model by disaggregating the modelled assets.

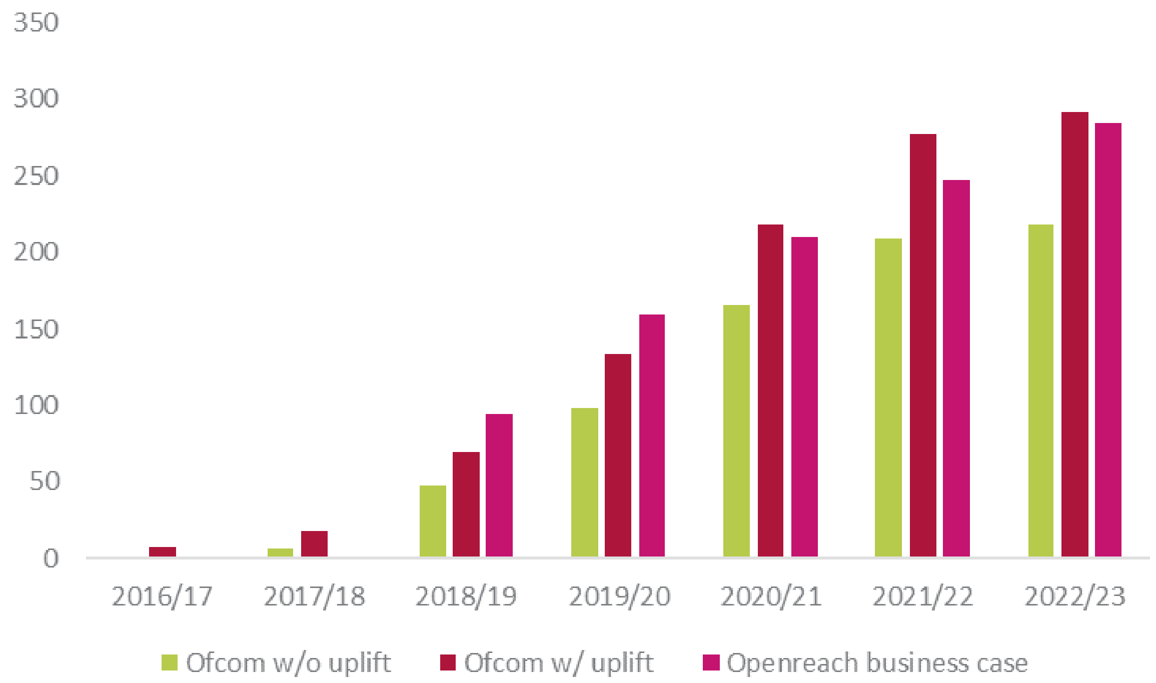
A14.128 We note that the latter option would require gathering further information about the unit costs and cost trends of new/disaggregated network elements, e.g. cabinet shell, DSLAM chassis, power distribution unit and cable rearrangement. Openreach provided the current unit cost for these disaggregated elements, but a lack of evidence regarding their likely future unit costs still exists as these elements are typically sold (by equipment manufacturers) as part of a bundle. As such, there is no historical information on the standalone price of these elements that would enable us to calculate a cost trend for each disaggregated element.

A14.129 Therefore, we have examined how closely option two would mirror the costs of deploying vectoring and carrying out the transformation programme as calculated in Figure A14.1. To do so we have used 2016/17 data provided by Openreach on the costs of buying and installing vector-capable DSLAMs and vectored cards to populate the unit costs in the bottom-up model. These costs do not include the additional costs from undertaking the transformation programme, such as replacement of cabinet shell, power distribution unit and cable rearrangement.

A14.130 To capture these additional costs, we have uplifted the 2016/17 unit costs for the DSLAM elements by 15%. This means that when DSLAM assets start getting replaced in 2017/18, after the first DSLAMs reach the end of their [✂] (~9.1) year asset life, we assume they are replaced at a higher cost. Given that movements in asset prices can lead to significant holding gains and thus impact our total (CCA) cost calculations we have spread this cost uplift over a 4-year period.[334]

A14.131 The impact of the uplift is illustrated in Figure A14.3. It shows that the cumulative DSLAM capex in the bottom-up model follows the adjusted capex in the Openreach NGA business case more closely, particularly by 2020/21.

Figure A14.3: Cumulative additional capex for DSLAM elements – £m



Source: Ofcom analysis of Openreach information

A14.132 We have cross-checked whether this result remains after depreciating the modelled capex using our CCA algorithm by converting the incremental transformation programme capex in the Openreach business case (i.e. the gap between the two bars in Figure A14.2 above) into CCA costs. We are satisfied that this is the case, implying we are including an appropriate level of cost.

A14.133 On the basis that option two captures an appropriate level of cost and that there are practical difficulties associated with implementing a more detailed modelling approach, we have decided to include the costs of deploying vectoring and undertaking the transformation programme in the bottom-up model using option two.

[334] This implies a 3.6% uplift per annum, starting from 2016/17. This adjustment is implemented in rows 172-175 of the "Input_CostTrends" tab in the Network Cost module.

Asset lives

Our proposals

A14.134 In our March consultation we used BT's accounting lives to inform the asset lives in the bottom-up model.

A14.135 We recognised that technological change in the WLA market meant that some network assets could get replaced before reaching the end of their accounting life, i.e. assets could become redundant due to the introduction of new technologies.

A14.136 We said that, if we were to find evidence of this, we would adjust the asset lives in the bottom-up model to reflect the faster depreciation of the underlying network assets.

Stakeholder responses

A14.137 TalkTalk, Sky, Vodafone and CityFibre commented on our proposed asset life duration. TalkTalk agreed with our proposal to adjust the assumed asset lives where network assets become redundant. However, it argued that "if assets are left stranded due to increased competition (which may or may not be from other technologies) or customers moving to an alternative BT network (most likely an FTTP network) then these FTTC assets should be allowed to be stranded, and should not be remunerated".[335]

A14.138 TalkTalk argued that the [~7.1][336] year asset life assumed for FTTC DSLAMs and cabinets was too short. It stated that "there appears to be no evidence to support this" given that BT has not replaced any cabinet as yet.[337] TalkTalk suggested that "an asset life of 10 years or more for FTTC DSLAMs and 15 years or more for FTTC cabinets seems likely to be appropriate".[338]

A14.139 Sky also considered that the 7.1 year asset life for FTTC DSLAMs was too short. It said that "carrier equipment such as DSLAMs typically have long asset lives and, although they may have an asset life of seven years for accounting purposes, they would not reach the end of their useful life over this time period".[339] It reasoned that in the context of a HON model, where capital expenditure is deployed to replace equipment rather than to upgrade it, an asset life of 7.1 years is too short.

A14.140 Sky also argued that a 7.1 year asset life is inconsistent with BT's actual FTTC network. It reasoned that "this assumption implies that BT would already need to begin replacing the

[335] TalkTalk response to the March 2017 WLA Consultation, paragraph 7.27.
[336] The actual asset life duration we used in our March 2017 WLA Consultation was redacted as it was confidential to BT. The [~7.1] used in our consultation was a randomised number, within a +/-20% range of the actual figure.
[337] TalkTalk response to the March 2017 WLA Consultation, paragraph 7.32.
[338] TalkTalk response to the March 2017 WLA Consultation, paragraph 7.33.
[339] Sky response to the March 2017 WLA Consultation, paragraph A3.3.

DSLAMs and cabinets it rolled out in 2010 and earlier", and that they "have seen no evidence to suggest that this is the case".[340]

A14.141 Vodafone commented along the same lines. It questioned whether "the assumption of asset lives actually reflects the useful economic life of the asset rather than simply the accounting depreciation life".[341] As an example, it referred to our 2014 WBA consultation. Vodafone stated that in that consultation "we investigated the issue of asset lives and the length of time BT actually use assets and found that in practice the economic lives of assets is considerably longer than the initial conservative asset lives assumed".[342] To support this claim it quoted our consultation where we found that a proportion of DSLAMs, SDH and ATM assets had been in service for 13 years.

A14.142 CityFibre disagreed with Sky, TalkTalk and Vodafone. It believed that "a life of 5 to 7 years is realistic for this type of asset and that this range is in line with practice seen internationally".[343] CityFibre noted that "DSLAM asset lives have tended to reduce in recent years, and that this trend is set to continue as new technologies offer higher speeds and increased range over the copper network".

Our reasoning and decisions

A14.143 In informing the asset lives in our bottom-up cost modelling, and in any cost modelling exercise for charge control purposes more generally, we are interested in understanding the economic life of the modelled network assets. This is the time period over which we would expect an efficient operator to use an asset in light of the asset's physical life as well as the possible technological developments which could accelerate the asset's replacement. In our March consultation we were of the view that BT's accounting lives could serve as a reasonable proxy for the economic life of the modelled FTTC assets.

A14.144 We have now reviewed further evidence from the latest Openreach NGA business case. It suggests that Openreach has not replaced any FTTC DSLAMs as yet, suggesting that the physical life of these assets can be longer than 10 years.

A14.145 However, the Openreach business case also suggests that DSLAMs in the Openreach network will start getting replaced from 2018/19 onwards as part of its vectoring/transformation programme. As mentioned above, we consider this programme to be consistent with our anchor pricing approach of modelling an ongoing FTTC overlay network. So, although the physical life of a DSLAM could be more than 10 years, technological change in the market means that the economic life of it could be shorter (i.e. under Openreach's vectoring programme, some DSLAMs will get replaced after 6 years of their installation).

A14.146 Using information from Openreach's vectoring programme and Openreach's cabinet rollout, already included in the bottom-up model, we have estimated the age that DSLAMs

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[340] Sky response to the March 2017 WLA Consultation, paragraph A3.3.
[341] Vodafone response to the March 2017 WLA Consultation, paragraph 10.7.
[342] Vodafone response to the March 2017 WLA Consultation, paragraph 10.8.
[343] CityFibre response to the September 2017 WLA Consultation, paragraph 2.2.4.

operating in the Openreach network are likely to be at the time of their replacement. To do this, we have assumed that older DSLAMs get replaced first (i.e. in the same order they were deployed).

A14.147 Our analysis suggests that DSLAMs in the Openreach network will have an average age of [✂] (~9.1) years by the time they get replaced.

A14.148 On the basis that our cost modelling should capture the economic life, rather than the accounting and/or physical life, of the modelled network assets, we have increased the asset life assumed for the DSLAM assets in the bottom-up model from [✂] (~7.1) to [✂] (~9.1) years.

In-life capacity growth

A14.149 In our March consultation we proposed using the cost volume relationships in the bottom up model to dimension the capacity growth in the modelled network. These cost volume relationships were informed by our understanding of the engineering and planning rules which are applied in the Openreach network.

A14.150 As part of its NGA business case update, Openreach submitted that our modelling understated the amount of incremental capex associated with in life capacity growth in its FTTC network.[344] This incremental capex is driven by the growing number of FTTC subscribers and bandwidth demand per subscriber over time, thus raising the need for cabinet uplifts, higher-density line cards, second cabinets and additional backhaul capacity.

A14.151 Openreach estimated that our modelling understated the amount of in life capacity growth capex by [✂] (£250m - £400m) over the period 2017/18 to 2020/21. Openreach identified the following categories of incremental in life capacity capex:[345]

- Higher-density cards, cabinet upgrades and second cabinets;
- PCP augmentation/uplift; and
- Additional headend capacity.

A14.152 We discuss each of these categories below.

Higher-density cards, cabinet upgrades and second cabinets

A14.153 As more FTTC lines get connected to the modelled network, the bottom-up model triggers additional DSLAM line cards as and when needed. This assumes the use of 64-port high-density cards (albeit adjusted to take account of [✂]). This means that when additional line cards are required, our modelling assumes the use of high-density cards.

A14.154 We have compared the costs for additional line cards in our bottom-up model against Openreach's business case[346] (over the period 2017/18 to 2020/21) to assess the

[344] No other stakeholder commented on this matter.
[345] Openreach response to questions 11 and 15 of the 36th s.135 notice dated 18 September 2017.
[346] Openreach response to question 11 of the 36th s.135 notice dated 18 September 2017.

reasonableness of our assumptions. The costs in the bottom-up model and Openreach business case appear to be reasonably aligned.[347]

A14.155 When there is no capacity left for additional line cards within existing DSLAMs, our bottom-up model triggers second cabinets. We note that, in the bottom-up model, the ratio of small to large cabinets is assumed to be fixed over time, therefore implying no cabinet upgrades. Although we believe that an efficient FTTC operator would replace a small cabinet with a larger cabinet before actually triggering a second cabinet, the design of the bottom-up model does not allow this to happen without leading to negative capex (as the number of small cabinets declines).

A14.156 Instead, the bottom-up model triggers second cabinets when the average capacity utilisation across each DSLAM type (small or large) reaches its full capacity. Despite this, the bottom-up model does not anticipate second cabinets will be required over the review period. This is in contrast with the Openreach business case which forecasts [✂] in additional capex on cabinet upgrades and second cabinets over the same period.[348]

A14.157 We consider this discrepancy is explained by the use of national averages in our bottom-up model. To assess this, we have analysed the distribution of the utilisation by cabinet in the Openreach network. Using 2016 Connected Nations take-up data we have estimated the utilisation rate in each FTTC cabinet to understand i) the number of small cabinets that might require an upgrade and ii) the number of large cabinets which are likely to reach their full utilisation and hence trigger a second cabinet.[349]

Cabinet upgrades

A14.158 Our analysis of the 2016 Connected Nations cabinet data suggests that the majority of cabinets within the Openreach FTTC footprint utilise 30% of their capacity or less; whilst only 5% of them utilise more than 70% of their capacity. When factoring in our volume forecasts for 2020/21, we estimate that a small cabinet using 45% of its capacity in 2016 would likely require an upgrade by 2020/21.

A14.159 These calculations do not consider the possible use of higher-density cards for addressing capacity constraint issues. However, Openreach confirmed that this option is only available to cabinets which are already vectored. The Openreach business case suggested that this will not happen until 2018/19 when the implementation of vectoring commences. Furthermore, Openreach's vectoring/transformation programme may not necessarily align with the need for cabinet upgrades as this programme requires the replacement of headends, and Openreach plans to phase this over a period of 5 years. Nonetheless, we believe that a fraction of Openreach cabinets requiring an upgrade could be addressed by the use of higher-density cards. To account for this we have used a more conservative

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[347] The Openreach NGA business case assumes [✂] (£50 – 75m) in incremental spend on additional line cards and higher-density line cards over the period 2017/18 to 2020/21. This compares to the [✂](£40-£65m) assumed in the bottom-up model over the same time period, excluding additional line cards from new cabinets and replaced cabinets.
[348] Openreach response to question 11 of the 36th s.135 notice dated 18 September 2017.
[349] By full capacity we mean the capacity that could be reached by exhausting all the line card slots available in the DSLAM chassis.

utilisation rate of 50%-70% (rather than 45%) to ascertain the likely number of small cabinets requiring an upgrade.

A14.160 We found that [✂] small cabinets were using more than [✂] of their capacity in 2016, while [✂] of them were using at least [✂]. On this basis, we estimate that [✂] (1,000-5,000) small cabinets in the Openreach network are likely to require a cabinet upgrade over the review period.

A14.161 We have compared this against the number of cabinet upgrades implied in Openreach's business case. We estimate this to be [✂] (c 2,900) based on the [✂] (£25m – £50m) total spend included in the Openreach business case for cabinet upgrades[350] and on the assumption that each cabinet upgrade would cost around [✂] (£11,600).[351]

A14.162 Given that the implied number of cabinet upgrades in Openreach's business case falls within our estimated range, we consider that Openreach's additional capex forecast is reasonable and thus consider it appropriate to include these costs in the bottom-up model.

A14.163 As previously explained the design of the bottom-up model does not allow the proportion of small cabinets to change over time. Therefore, to implement these costs we have considered the following two options:

- Option 1: change the structure of the model to allow the proportion of small cabinets to change and add new network elements to capture the costs of cabinet upgrades.
- Option 2: keep the model structure as it is but uplift the number of cabinets in the model to capture the additional costs.

A14.164 For both options we would use the Openreach capex figure to inform the extent to which we would vary the model parameters (i.e. the proportion of small cabinets for option 1 and the number of additional cabinets for option 2), so both should lead to a similar outcome in terms of the additional capex to include in the model.

A14.165 However, the additional total costs (after depreciating the modelled capex) could differ between the two options. This is because the different mix of assets underpinning the two options could lead to a different asset life over which to spread the additional capex. A cabinet upgrade is likely to reuse some of the civils already in place (e.g. power supply, alarms), meaning that the average asset life of a cabinet upgrade (Option 1) could be shorter than the average asset life of an entire new cabinet (Option 2). This, however, could be partly offset by the cabinet upgrade reusing some of the existing electronics, including the optics, which would have the effect of increasing the average asset life of the assets being replaced.

A14.166 Having said that, we believe that any difference in the implied asset life between the two options is not likely to have a material impact on the charge control given the scale of the additional capex i.e. [✂] (£25m - £50m). Therefore, we find that the more complex modelling refinements added by option 1 would not deliver any material benefit in terms

[350] Openreach response to question 11 of the 36th s.135 notice dated 18 September 2017.
[351] This assumes that a cabinet upgrade requires i) replacing the DSLAM chassis, lines cards, shell and plinth; and ii) putting down additional copper tie cables.

of the overall result. On this basis, we have included the additional costs from cabinet upgrades in the bottom-up model using option 2.

A14.167 Table A14.5 below shows the number of cabinets added to the bottom-up model.

Table A14.5: Additional cabinets included in the bottom-up model to account for cabinet upgrade costs over the period 2017/18 to 2020/21

	2017/18	2018/19	2019/20	2020/21
Additional cabinets	[✂] (~662)	[✂] (~469)	[✂] (~600)	[✂] (~277)

Source: Ofcom analysis

Second cabinets

A14.168 Similar to the analysis above, we have assessed the extent to which large cabinets in the Openreach network are likely to reach their full capacity, and hence trigger the need for a second cabinet before 2020/21.[352] Using the 2016 Connected Nations cabinet data, we calculated the number of large cabinets which had a utilisation rate of at least 50% to 70% as at 2016.

A14.169 We found that [✂] (3,000 – 5,000) large cabinets used more than 50% of their capacity, while [✂] (0-2,000) of them used at least 70%. On this basis we estimate that between [✂] (0-2,000) and [✂] (3,000 – 5,000) large cabinets will require a second cabinet over the review period.

A14.170 This compares to the [✂] (1,000 – 3,000) second cabinets included in the Openreach business case.[353] Given that Openreach's forecast falls within our range estimate we consider that it is appropriate to include these cabinets in the bottom-up model. Therefore, we have included an additional [✂] (1,000 – 3,000) cabinets in the bottom-up model.[354]

A14.171 To estimate the cost of these second cabinets we have assumed the following:

- Cabinet costs: same costs as for first cabinets. After analysing the cost information provided by Openreach, we conclude that the cost items driving the majority of the civil costs of a second cabinet are the same as for first cabinets (e.g. management of the power connection, power jointing charges, concrete base, earthing mat, survey, power certification, etc).
- Backhaul costs: no backhaul costs included as we would expect an efficient operator to reuse the fibre cables used to connect the first cabinet.

[352] By full capacity we mean the capacity that could be reach by exhausting all the line card slots available in the DSLAM chassis.
[353] Openreach response to questions 11 and 15 of the 36th s.135 notice dated 18 September 2017.
[354] This change is implemented in row 15 of the 'Input_Coverage' tab of the Network Cost module.

A14.172 The table below shows the number of second cabinets added to the bottom-up model over the period 2017/18 to 2020/21. We have spread these cabinets as per the rollout in the Openreach business case.

Table A14.6: Second cabinets included in the bottom-up model over the period 2017/18 to 2020/21

	2017/18	2018/19	2019/20	2020/21
Second cabinets	[✂] (~458)	[✂] (~489)	[✂] (~390)	[✂] (~292)

Source: Ofcom analysis

PCP augmentation/uplift

A14.173 Openreach submitted that it will spend [✂] (£50m - £100m) to uplift existing PCP cabinets and to expand copper and duct capacity between the PCP and FTTC cabinets, over the period 2017/18 to 2020/21.[355] It explained that PCP cabinet uplifts may be required when a bigger shell is needed to accommodate a larger number of tie cables.

A14.174 Openreach also noted that it does not install the full number of tie cables required to connect all ports in a DSLAM from day one. Rather, it installs additional tie cables as and when needed. This is, however, only the case for large (Type 2) cabinets where utilisation is not expected to reach [✂] (60-90%) and for which Openreach deploys [✂] (60-90%) of the total number of possible tie cables from the start.[356]

A14.175 The bottom-up model, by contrast, assumes that all tie cables are installed as soon as the cabinet is deployed. This means that our modelling over-dimensions the amount of tie cable and tie duct deployed in the Openreach network. So, although our modelling understates the amount of capex required in later years of the network rollout, when take up of FTTC services grows, it overstates the capex in the initial years.

A14.176 We believe that neither approach is necessarily inefficient. An efficient operator may decide to install the full capacity from day one and avoid having to send an engineer back to the cabinet when additional tie cables are required down the line. An efficient FTTC operator could also decide to de-risk the project and not deploy the full capacity upfront and install additional tie cables as and when needed (Openreach's strategy). The latter could be a reasonable strategy when, at the outset of the project, the level of take-up is uncertain and/or when new technologies are expected to be introduced in later years and hence cannibalise some of the demand of the existing technology.

A14.177 In our March consultation we provisionally considered that installing the full number of tie cables from the start was a reasonable strategy for a hypothetical ongoing FTTC network. This is particularly the case given that, different to the Openreach network, our modelling assumes that new technologies will not be deployed by the modelled network, hence implying no cannibalisation effect. We remain of the view that this is an appropriate

[355] Openreach response to question 11 of the 36th s.135 notice dated 18 September 2017.
[356] BT Model documentation submitted in response to question 8a of the DPA s.135 notice dated 16 June 2017.

approach and have therefore not made changes to our modelling of this aspect as part of this statement.

A14.178 However, we have uplifted the proportion of cabinets which require re-shelling in the bottom-up model as our assumption in our March consultation was based on the actual number of re-shells carried out in the Openreach network. We now know that this is an underestimate for a network where the full number of tie cables are deployed from day one. In the absence of actual data for this hypothetical scenario, we have used Openreach's estimate of the additional capex required for PCP re-shells over the 2017/18 to 2020/21 period (which amounts to [✂] (£20m - £50m) as a proxy. We have used this information to then work out the re-shell rate that would produce such additional capex. As a result, we have adjusted the re-shell rate assumed in the bottom-up model from [✂] (~18%) to [✂] (~39%).

Additional headend capacity

A14.179 The Openreach business case assumes [✂] (£20m - £50m) in new headends will be required to support the growth of its FTTC network and [✂] (its transformation programme) over the period 2017/18 to 2020/21.[357] This includes the costs of installing new headend models which can be shared with the NGA2/G.fast network. Compared to the standard headends deployed in the initial phase of the FTTC rollout, these new headends cost [✂] (30-60%) more, once port capacity is accounted for.

A14.180 In paragraph A14.115 we concluded that it would be inappropriate to include costs to upgrade headends and/or provide 10GE as part of Openreach's NGA2 deployment, or to upgrade the FTTC network so it can be shared with the NGA2 network, in the charge control. We have therefore adjusted Openreach's estimated capex to account for the cost premium of NGA2 headends. This suggests an additional capex of [✂] (£10m - £20m) by 2020/21.

A14.181 We have compared this cost figure against the modelled capex in the bottom-up model. Our modelling predicts [✂] (£10m - £20m) additional capex in headend equipment and infrastructure over the same period, which is reasonably in line with the adjusted Openreach cost estimate. Therefore, we do not consider it necessary to make further changes to our modelling in this case.

Power costs

Our proposals

A14.182 In our March consultation we proposed to derive the power costs for the modelled network based on information provided by Openreach on the cost per KWh of electricity and the electricity costs allocated in the 2014/15 RFS to GEA services.

[357] Openreach response to question 13 of the 42nd s.135 notice dated 7 December 2017.

A14.183 We used this cost information to work out the average power consumption per cabinet in the Openreach network for 2014/15, which we estimated to be [✂] (~0.12) KW per annum. For the remaining years we assumed this power consumption per cabinet would stay constant and used the compounded annual KW rate growth over the period 2015/16 to 2019/20 to derive power costs beyond 2019/20.

A14.184 Power costs at the exchange were modelled separately and were informed by the assumptions in the Openreach Model. These costs were included in the bottom-up model as part of the accommodation costs at the exchange.

Stakeholder responses

A14.185 As part of its NGA business case update, Openreach submitted the costs of running its commercial FTTC network over the period 2008/09 to 2028/29.[358]

A14.186 Openreach explained that for 2014/15, the NGA business case assumes higher costs than included in the RFS. This is because it considered that the electricity spend recorded in the 2014/15 RFS was not consistent with cost trends observed for subsequent years. The NGA business case, Openreach explained, therefore takes the mid-point between the 2013/14 and 2015/16 RFS costs. For the remaining years, the power costs in the NGA business case are consistent with those in the RFS.[359]

Our reasoning and decisions

A14.187 We have updated our analysis of the electricity costs in the Openreach network using the 2015/16 and 2016/17 RFS cost information. This suggests a higher power consumption per cabinet ([✂] (~0.27) KW) than suggested by the 2014/15 RFS ([✂] (~0.12) KW). Openreach explained that power consumption at the cabinet level is expected to increase with higher FTTC take up, but could not explain the totality of the discrepancy saying that they had used a higher cost figure for 2014/15 in their NGA business case update.

A14.188 We agree with Openreach that power costs are likely to be affected by the level of take-up. We have used the 2015/16 and 2016/17 RFS costs to derive the power consumption per subscriber line. This suggests a per line power consumption of [✂] (~31) for 2015/16 and [✂] (~21) KW for 2016/17. We consider that the power consumption in 2016/17 better represents the electricity costs going forward; therefore, we have used this to estimate the power costs in the bottom-up model.[360]

[358] Openreach response to question 7c of our 42nd s.135 notice dated 7 December 2017.
[359] Openreach response to question 7c of our 42nd s.135 notice dated 7 December 2017.
[360] This is implemented in rows 14 to 17 in the "Input_ElementCosts" worksheet of the Network Cost module.

Maintenance costs

Our proposals

A14.189 The bottom-up model published in the March consultation included maintenance costs for FTTC cabinets. We based these costs on the assumptions used in the Openreach Model, namely that there would need to be:

- three visits every year to every FTTC cabinet, taking 30minutes each, and a yearly visit taking 60 minutes; and
- three residual current device (RCD) checks every year to each FTTC cabinet requiring manual RCD maintenance, taking 45 minutes each, and a yearly RCD check taking 2 hours;

A14.190 We understood these assumptions were based on the policy guidelines applied in the Openreach network. In addition, we allowed for c.10 min travel time for each maintenance visit.

A14.191 Our model then applied the assumed pay rate to estimate the total maintenance costs for the modelled network.

Stakeholder responses

A14.192 In response to our consultation Openreach submitted its NGA business case update. As a follow up to its submission, Openreach split out the FTTC maintenance costs included in its business case. These suggested lower maintenance costs than included in the bottom-up model.

A14.193 Openreach also clarified that the maintenance policies in the Openreach network had recently changed. According to Openreach the quarterly and yearly visits were no longer carried out and that these had been replaced with automatic RCD checks and electricity checks every 2.5 years.[361] It also explained that these 2.5 year checks take two hours each, with travel time included.

Our reasoning and decisions

A14.194 We consider that the new maintenance policies in the Openreach network are reasonable and consistent with the behaviour expected from an efficient operator. We have therefore updated our modelling to reflect these new polices. This had the effect of reducing the average annual maintenance cost per cabinet from [✂] (~126) in 2016/17 to [✂] (~22) in 2017/18.

[361] Openreach response to question 16a of our 42nd s.135 notice dated 7 December 2017.

OSS/BSS costs

Our proposals

A14.195 In our March consultation we proposed to base these costs on Openreach's actual capital and operational spend in its NGA programme. We also proposed to base these costs on Openreach's total national spend, without distinguishing between commercial and non-commercial areas, nor between FTTC and non-FTTC costs. We took the view that OSS/BSS costs were largely fixed and hence would not vary by the breadth of the product portfolio nor its geographic reach.

A14.196 To depreciate these costs we proposed to use an asset life of 5 years for hardware-related investments and 10 years for software-related investments. For operational spend we used Openreach's actual spend in 2014/15 and 2015/16 and extrapolated the spend for the remaining years by keeping the proportion of total OSS/BSS capex constant.

A14.197 We also noted that BT does not allocate all of the incremental OSS/BSS spend associated with its NGA programme to GEA services. We found that only c.[✂] (~13%) of the identified incremental OSS/BSS spend is allocated to GEA; while the remainder is allocated to copper and non-WLA services. We proposed to address this as part of our cost attribution review by making proposals on how BT should apportion these costs in the RFS.

Stakeholder responses

A14.198 As part of its NGA business case update, Openreach provided its most recent view of the incremental OSS/BSS spend associated with its commercial FTTC rollout.

A14.199 Vodafone argued that "OSS/BSS costs are incurred by all network operators and are generally included in all bottom-up FTTC network models; therefore it is Vodafone's strong view that it is more appropriate to source this data from industry benchmarks rather than BT". It said that "there are very good reasons why BT's OSS/BSS costs will be significantly higher than that of an equally efficient operator", as "BT's network is complex and extensive carrying many services".[362]

A14.200 Vodafone also argued that "if historically within BT's RFS only 13% of OSS/BSS costs were allocated to GEA service, then going forward they would expect no more than 13% of costs to be allocated to the GEA charge control model" to avoid double recovery.[363] It questioned the reason why we reviewed BT's attribution of OSS/BSS costs in the RFS for 2011/12, 2012/13, and 2015/16 but not for 2014/15. It also asked us to confirm whether the additional fibre specific OSS/BSS costs provided by BT were allocated previously to GEA services within the RFS.

[362] Vodafone response to the March 2017 WLA Consultation, paragraph 12.7.
[363] Vodafone response to the March 2017 WLA Consultation, paragraph 12.7.

Our reasoning and decisions

A14.201 We have compared the inputs in the bottom-up model against the OSS/BSS spend in the Openreach business case update. We found that the cumulative capex in the business case is lower than in the bottom-up model by around [✂] (~£34m). Openreach clarified this was due to [✂] (~£17m) identified as part of the BDUK rollout, and [✂] (~£17m) spend incurred in 2008/09 and which was not included in the business case because Openreach could not isolate commercial FTTC specific costs from other costs, e.g. FTTP, BDUK, in an accurate way.[364]

A14.202 Consistent with our modelling approach of excluding non-commercial costs, we have removed the [✂] (~£17m) identified by Openreach as driven by BDUK.

A14.203 We have also considered whether to remove the other [✂] (~£17m) for which Openreach could not exclude costs not relating to its commercial FTTC deployment. As mentioned above, these costs were incurred back in 2008/09 – ahead of Openreach commencing its BDUK rollout. For this reason, we do not believe these costs include BDUK related costs.

A14.204 However, it could be possible that some of these costs are FTTP related. To assess this, we have looked at the OSS/BSS spend in 2009/10 to examine the extent to which any of this could be driven by FTTP. The management accounts, however, identify all of this spend as FTTC specific. We consider that this is reasonable given that Openreach's FTTP deployment has been minimal until now; and even if it had been more substantial, these costs are unlikely to have been materially different given that OSS/BSS costs are largely fixed[365]. Consequently, the evidence suggests that these [✂] (~£17m) costs were driven by Openreach's commercial FTTC deployments and thus we have not removed them from the bottom-up model.

A14.205 Regarding Vodafone's concern that including all of the incremental OSS/BSS spend in the bottom-up model could lead to Openreach over recovering these costs, as only a small proportion of them are actually allocated to GEA services in the RFS, we have updated our March consultation analysis of the RFS. When adding the 2016/17 OSS/BSS spend, we find that only [✂] of the total incremental OSS/BSS spend is allocated to GEA services in the RFS, which is close to the figure we calculated in our March consultation (c.[✂] (~13%)). The remaining spend is allocated to copper services and non-WLA services (mostly leased lines).

A14.206 We consider that it is appropriate to keep these costs in the bottom-up model as our modelling aim is to capture the incremental costs of supplying fibre services. However, we recognise that doing so would lead to double counting these costs within our charge controls. To avoid this, we have removed the portion of the incremental OSS/BSS costs that is allocated to copper services in the RFS from our top-down model. We will also seek to

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[364] Openreach response to question 12 of the 42nd s.135 notice dated 7 December 2017.

[365] For our March consultation we engaged telecoms providers to understand how sensitive OSS/BSS costs were both to the size of the product portfolio and the network footprint. In particular, our discussions with [✂] suggested that OSS/BSS costs are largely a fixed cost, and that one would not expect these costs to change with the number of products offered in the market and/or the network reach.

remove the remaining portion of these costs that is allocated to controlled business connectivity services in our next BCMR, where appropriate.

Customer installation costs

A14.207 These costs are associated with the activities required for connecting new customers to the FTTC network. The activities required will depend on the type of connection but might include receiving and processing new orders and jumpering tie cables at the street cabinet.

Our proposals

A14.208 In our March consultation we proposed to model the cost of these connection activities based on the cost assumptions in the Openreach Model. These assumptions provide information on the pay and non-pay cost elements of each connection activity (whether it is customer site installation, Service Management Centre (SMC) or PCP jumpering).

A14.209 We noted that customer installation costs are treated as operating costs in the bottom-up model. This was in contrast with BT's practice of capitalising a portion of these costs in its management accounts and RFS.[366] We have not followed this practice given that we are allowing BT to recover customer installation costs via one-off charges; thus, effectively allowing BT to recover these costs within the same year they are incurred. On this basis, we took the view that it would be inappropriate to treat part of these costs as capex, and allow BT to earn a return on costs which have been fully recovered.

Stakeholder responses

A14.210 As part of its NGA business case submission, Openreach provided information on the customer installation costs that it has incurred and expects to incur over the period 2008/09 to 2028/29 in relation to its commercial FTTC network. These costs are generally lower than those in the bottom-up model, particularly over the charge control period.

A14.211 Vodafone agreed with our proposed approach to not allow BT a return on capitalised costs which are recovered from a one-off charge at the time the costs were incurred. It also assumed BT would be "matching costs with revenues, thus if BT recognise revenue in the form of one-off charges in the year […] they would not be capitalising these costs at all in their accounts".[367]

Our reasoning and decisions

A14.212 To investigate the discrepancy between the customer installation costs in the Openreach NGA business case and our bottom-up model we requested further information from Openreach.

A14.213 We found that while the underlying unit costs in the Openreach business case are similar to those in the bottom-up model, the service volumes underpinning the customer

[366] Openreach response dated 25 November 2016 to Question 14 of the 19th s.135 notice.
[367] Vodafone response to the March 2017 WLA Consultation, paragraph 12.10.

installation costs are significantly different, with the number of FTTC connections in the NGA business case being lower than in the bottom-up model.

A14.214 We have decided not to make any changes to our modelling approach because:

- we consider it is appropriate to use the volumes derived from our volume model rather than Openreach's figures in the NGA business case;
- we have adopted a LRIC cost standard for setting charges for FTTC connection services; and
- all network costs driving the LRIC of customer installations in the bottom-up model are volume sensitive (and thus volume changes should not affect the estimated unit cost of the service).

Cumulo

A14.215 Cumulo rates are the non-domestic (business) rates that BT pays on the rateable assets within its UK network. The rateable assets consist primarily of duct, fibre, copper and exchange buildings.

A14.216 As proposed in our consultations, we have decided to include cumulo costs in the bottom-up model since deploying a FTTC overlay network entails expanding the stock of rateable assets in the Openreach network. Annex 21 details how we have determined the cumulo assumptions in the bottom-up model and addresses the comments we have received from stakeholders on this matter.

Repair costs

A14.217 The bottom-up model includes repair costs within the unit operating costs of each network element.

A14.218 We explained in our March consultation that these costs were estimated based on the fault rates assumed by equipment manufacturers.[368] This is because we considered that actual fault rates in the Openreach network were likely to be more reflective of an early life network rather than of an ongoing network. We used this information, together with the expected task times to repair these faults[369] and our assumption of BT's average pay rate,[370] to calculate the repair costs per unit of network element per year.

A14.219 No stakeholders commented on our consultation proposals and we have not made changes to these calculations since our March consultation except for the average pay rate which has now been updated to reflect 2016/17 pay rates.

A14.220 The bottom-up model also captures the extra repair costs in the existing copper network due to the provision of FTTC services. In our 2018 QoS Statement we found evidence of GEA customers originating more faults in the copper network than copper-only customers.

[368] These fault rates were informed by the assumptions in the Openreach Model as per BT's response dated 13 September 2016 to Question 11a of the 14th WLA CC s.135 notice.

[369] Openreach response dated 13 September 2016 to Questions 24 and 27 of the 14th s.135 notice.

[370] This is based on BT's average pay rate as per its 2014/15 RFS, updated by pay rate inflation in 2015/16.

However, our analysis also indicated that GEA fault rates would reduce over the control period due to the effects of Openreach's preventative maintenance programme and underlying trends in technology. Our GEA-FTTC fault rate forecasts are presented below.

Table A14.7: Expected fault rates for GEA-FTTC services

Charge control period	Base Year 2016/2017	Year 1 2018/2019	Year 2 2019/2020	Year 3 2020/2021
WLR+GEA-FTTC	[✂]%	[✂]%	[✂]%	[✂]%
MPF+GEA-FTTC	[✂]%	[✂]%	[✂]%	[✂]%

Source: Ofcom analysis of Openreach data

A14.221 We have used these fault rates and our service volume forecasts to estimate the repair costs accrued to the modelled FTTC network.

A14.222 In our 2018 QoS Statement we are also putting in place quality standards on BT for both installation and repair of GEA-FTTC services. To meet these standards, BT will need to hire extra resources. In our 2018 QoS Statement, we estimated these additional resources will increase BT's repair costs by 14.1% towards the end of the charge control, and we have allowed BT to recover these costs by applying a cost uplift on the relevant cost components over the charge control period.

A14.223 We have implemented this cost uplift in the bottom-up model by adjusting our opex cost trend assumptions. This adjustment reflects:

a) the cost uplift estimated by our quality of service consultation for each year over the charge control period; and

b) the contribution repair costs have on the unit opex of each network element.

A14.224 We estimate this adjustment has an overall impact of 69p per annum on our forecasted GEA rental charge.

SLG payments

A14.225 In Annex 13 we estimate the efficient level of SLG payments over BT's fibre access network. These are calculated for the base year (2016/17) as well as for the years over the charge control period. We do so by taking into account expected improvements throughout this period for QoS parameters (i.e. the fault rate, the proportions of faults and provisions where SLGs will be payable and the average duration of those SLGs) and by assuming that BT's performance will reach efficient levels by 2020/21. We also take into account the expected impact of retail automatic compensation on the daily SLG amount Openreach will pay telecoms providers.

A14.226 For the years prior to 2016/17, we have taken BT's performance for the various quality of service parameters observed in 2016/17 (the year for which we have most recent BT data) and have applied these to our historical volumes from 2010/11 to 2015/16.

General Management costs

Our proposals

A14.227 In our March consultation we proposed to include General Management (GM) costs which are incremental to the FTTC network in the bottom-up model. We proposed to base these costs on the GM costs BT allocates to GEA services in the RFS, adjusted to reflect LRIC rather than FAC costs.

A14.228 Given that we only had information on these costs for 2014/15 and 2015/16 we had to make assumptions about the level of GM costs for the remainder of the modelling period. We assumed that GM costs are dependent on the size of the network opex and hence proposed to calculate these costs as a proportion of the total opex estimated for the modelled network (excluding GM and cumulo costs). Based on the 2015/16 RFS (which reflected the latest information at that time), we proposed to assume GM costs represent ([✂] (20-50%)) of the network opex (excluding GM and cumulo costs).

Stakeholder responses

A14.229 Only Vodafone commented on this matter. It asked Ofcom to clarify if it was “the case that general management costs represent between 20%-50% of the total modelled operating costs in addition to the shared and common management overhead costs that are added as discuss by Ofcom”.[371] Vodafone clarified that these additional costs are the overhead and other shared costs common to MPF, WLA and other access services. It also asked Ofcom to explain, “as a proportion of the total operating cost stack calculated for FTTC GEA services, what proportion relates to management and management overhead type costs”.

Our reasoning and decisions

A14.230 We have re-run our analysis using the 2016/17 RFS costs. This suggests that GM costs represent [✂] (15% - 45%) of the modelled opex (excluding GM and cumulo costs). When taking GM costs into account as part of the modelled opex, this proportion reduces to [✂] (10% - 30%).

A14.231 The equivalent proportions for 2015/16 are [✂] (20% - 50%) and [✂] (15% - 45%) respectively, which are not too dissimilar to the 2016/17 figures. We note that the proportion for 2015/16 has changed from our March consultation because of changes to the modelled opex. The change in the share of GM costs between 2015/16 and 2016/17 is therefore explained by a combination of modelling updates and a variation in the underlying relationship between GM costs and total network opex.

A14.232 We believe that the 2016/17 RFS cost information is more indicative of the GM costs in the Openreach network going forward and, on this basis, we have used this to inform the GM costs for the modelled network. Therefore, we have assumed that GM costs represent [✂] (10% - 30%) of the modelled opex (excluding GM and cumulo costs).

[371] Vodafone response to the March 2017 WLA Consultation, paragraph 12.11.

E-side and Remote duct costs

A14.233 These are the costs associated with repairing existing ducts and building new ducts in the E-side and Backhaul segments of the FTTC overlay network.

A14.234 We proposed in our March consultation and have decided to model these costs on a top-down basis (rather than on a bottom-up basis). Only Vodafone commented on our proposals, requesting a clarification.

A14.235 Vodafone questioned whether the duct costs coming from BT's RFS are really related to the incremental costs of providing FTTC or whether in fact they are simply due to BT's historic under investment in its core network.[372] With regards to Vodafone's response, as explained in paragraph A14.60, we have not sought to capture the incremental duct costs of supplying FTTC services, but the duct costs BT allocates in its accounts to GEA services. This is to mitigate the risk of under- or over-compensating BT as ducts are shared by a range of services including WLA and non-WLA services.

A14.236 We have decided to model E side and Remote duct costs on a top-down basis for a number of reasons. First, we have questions about the reliability of the bottom-up cost data we have received from Openreach in relation to duct. Openreach provided the average number of meters of new and repaired E-side duct (per every new km of E-side fibre) it assumes in its Openreach Model. It explained, however, that in practice engineers typically face flooded and congested ducts more often than suggested by these assumptions, which have not been updated accordingly.[373]

A14.237 We also have concerns that including the full incremental duct costs in the bottom-up model could result in a cost recovery problem. This is because BT allocates duct costs from a common pool of costs, shared by services such as copper, GEA and leased lines. We understand that the basis for allocating these costs is not necessarily reflective of the LRIC of each individual service (BT apportions duct costs based on a 1997 duct survey and these values are updated for GEA services based on GEA tie cable depreciation costs)[374]. Hence, we believe that doing a bottom-up calculation could carry the risk of BT under- or over-recovering its overall duct costs where these bottom-up calculations differ from BT's allocations.

A14.238 To avoid such a cost recovery problem, we have decided to capture E-side and Remote duct costs via a top-down allocation based on RFS costs. To inform this allocation we have used the duct costs BT apportions to GEA services (excluding BDUK costs) in its RFS for the years 2014/15, 2015/16 and 2016/17.[375]

A14.239 To project E-side and Remote duct costs backwards and forwards, we have assumed the same profile of cost recovery as our modelled tie duct costs in the bottom-up model. This

[372] Vodafone response to the March 2017 WLA Consultation, paragraph 12.14.
[373] Meeting between Ofcom and BT staff on 14 July 2016 in relation to BT's response to the 8th WLA CC s.135 notice.
[374] Cartesian, 2015. *BT Cost Attribution Review*, section 5.4,
https://www.ofcom.org.uk/__data/assets/pdf_file/0025/83482/ofcom_bt_cost_attribution_review_final_report.pdf.
[375] These costs are added to our unit LRIC estimate in the Cost Recovery module.

approach is consistent with the way BT attributes duct costs to GEA services in the RFS, as described above.

Openreach's Fibre First programme

A14.240 In our March consultation, we assumed that Openreach's commercial FTTC rollout was largely complete and that we did not expect any significant further commercial FTTC rollout over the charge control period. On this basis we assumed that the modelled network footprint would not expand further beyond 2015/16.

A14.241 On 1 February 2018, Openreach announced its "Fibre First" plan to expand its FTTP network from [✂] to 3m premises by 2020.[376] In response to a s.135 notice ,[377] Openreach explained that of the additional [✂] premises to be passed under this plan, [✂] (0.5m – 1m) are new sites (which are discussed in the next section), [✂] (0.1m – 0.5m) are BDUK premises and [✂] (1.5m – 2m) are premises located within its commercial footprint. It also explained that [✂] (50-70%) of the [✂] (1.5m – 2m) premises in the FTTP footprint will overlap with its existing FTTC network and the [✂] (30-50%) of the [✂] (~600,000 – 800,000) will be in areas where Openreach has a copper network but fibre has not been deployed (we refer to these as 'copper only premises').[378]

A14.242 In modelling the costs of fibre services, we are interested in capturing the costs of an efficient ongoing FTTC network. On this basis we consider that it is appropriate to include costs associated with the expansion of the NGA network to commercial areas where FTTC is not yet available. Consequently, we have sought to model the costs of extending the FTTC network to the [✂] (~600,000 – 800,000) copper only premises that will be passed by Openreach's FTTP network during the charge control period. This is consistent with our anchor pricing approach where we model FTTC as the anchor technology for the GEA 40/10 service that we are charge controlling.

A14.243 To assess the costs of this we asked Openreach to provide the list of cabinets and exchanges currently serving these [✂] (~600,000 – 800,000) copper only premises.[379] Openreach clarified that almost a third of these premises are exchange only lines, whilst the others are cabinet lines.

A14.244 Using this information, and drawing on take-up data at a cabinet level from the 2016 Connected Nations report, we have calculated the number of additional FTTC cabinets required to pass the [✂] (~600,000 – 800,000) copper only premises. In doing this we have excluded cabinets which are already included in our modelling because they are either already FTTC enabled or planned to be enabled as part of Openreach's FTTC rollout plans.

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[376] See https://www.homeandbusiness.openreach.co.uk/news/fibrefirst.
[377] Openreach's response to question 1 of the 47th s.135 notice dated 6 February 2018.
[378] Openreach's response to question 1 of the 47th s.135 notice dated 6 February 2018.
[379] Openreach's response to question 9 of the 47th s.135 notice dated 6 February 2018.

A14.245 As a result of this analysis we have added [✂] new FTTC cabinets to the bottom-up model. We have spread deployment of these cabinets over three years, starting from 2018/19 and assuming they are equally distributed over the rollout period, [✂].

A14.246 To estimate the costs of these cabinets we sought to understand the extent to which they might differ from the rest of the commercial FTTC deployment. As mentioned above, a significant portion of these cabinets are meant to address exchange only lines. This means that for these new cabinets a new copper cabinet would need to be installed, which was not generally the case for the existing FTTC deployment. However, at the same time, these cabinets would require less E-side fibre as they are likely to be placed closer to the exchange. Therefore, it is unclear whether these new cabinets will have a different cost to the cabinets deployed in the initial phase of the FTTC rollout.

A14.247 We asked Openreach to provide information on the likely magnitude of the FTTC-equivalent costs for connecting these premises, including any analysis undertaken of the relative costs and benefits of deploying FTTP (in comparison to FTTC).[380] Openreach confirmed that it has not conducted such analysis. In the absence of this, we have used the unit cost assumptions in the bottom-up model to approximate these costs. We believe that this is reasonable as our bottom-up modelling represents our best view of the costs of deploying an efficient FTTC network.

A14.248 As a cross-check, we have verified whether our estimated MPF + GEA 40/10 unit LRIC+ would support Openreach's FTTP investment plans for copper only premises. In these cases, we would expect FTTC to be more expensive and/or drive less revenue (on a unit basis) than FTTP as Openreach would have otherwise not chosen to use FTTP to connect these premises.

A14.249 Our analysis shows that the MPF + GEA 40/10 price would allow recovery of the FTTP costs in BT's business case for FTTP deployment to copper only premises. This is before considering any potential price premium, over and above our controlled MPF + GEA 40/10 price, that Openreach could charge for services delivered over its FTTP platform. On this basis we consider that our approach to modelling these network expansion costs is unlikely to undermine Openreach's FTTP investments.

New sites

Our proposals

A14.250 Consistent with our anchor pricing approach, in our March consultation we assumed that all new sites (households and businesses) are connected to the copper network and then offered fibre services through an FTTC overlay network.

A14.251 In the WLA Volumes module we assumed that the number of households in the UK grows at an annual rate of 1% over the charge control period, which implies around 250,000 new

[380] Openreach response to question 10 of the 47th s.135 notice dated 6 February 2018.

households per annum. We then made assumptions about the level of broadband take-up to convert these new premises into additional copper and fibre volumes.

A14.252 For business line forecasts the WLA Volumes module applied our default approach of a three-year moving average growth rate with a dampening factor of 1.4 (see Annex 10 for details).

A14.253 The additional volumes coming from new households and businesses then fed into the top-down and bottom-up models, driving additional costs. These additional volumes were not treated differently to service volume growth coming from premises already connected to the copper network. That is, our modelling applied the same cost-volume relationships that we applied to connected premises to unconnected premises.

Stakeholder responses

A14.254 In its response to our March consultation, Openreach submitted that the costs of connecting new sites using FTTP are missing in the bottom-up model.

A14.255 Openreach explained that it plans to [✂] and estimated this will require a total capex of [✂] (£500m - £1bn) over the next 10 years.

Our reasoning and decisions

A14.256 As previously explained, we have adopted an anchor pricing approach whereby all service volumes in the bottom-up model are assumed to be delivered over an ongoing FTTC overlay network. These include volumes arising from new households and businesses.

A14.257 In our March consultation we did not make a specific cost assumption for volumes driven by new sites. Instead we assumed these volumes drive the same costs as volumes from connected premises. We accept this is a modelling simplification and that the costs for new sites are likely to be higher than for connected premises as new infrastructure needs to be built in order to connect the former.

A14.258 In our view the main incremental cost to supply FTTC services to new sites is extending the D-side copper network. Our existing top-down modelling allows for additional D-side copper costs through the application of CVEs and AVEs to incremental volumes. This means that by including additional volumes from new households and premises, our cost modelling allows Openreach to recover higher costs. This is the same methodology we have applied in previous copper charge controls and we do not see any reason why we should change this approach for this price review.

A14.259 Connecting new sites may also require incremental FTTC investments to the extent that new FTTC cabinets are required. In the bottom-up model new FTTC cabinets are triggered once existing cabinets reach, on average, their full capacity. Therefore, to the extent that the additional volumes from new sites lead to this threshold being reached, our modelling would allow for incremental FTTC costs.

A14.260 This approach is likely to understate the incremental FTTC costs required to connect new sites as new FTTC cabinets may be required where existing cabinets nearby do not have enough capacity or are too far away to deliver FTTC. This, however, would require information about the location of future new sites. In the absence of this information we have compared the capex included in our model for new sites against Openreach's expectation of spend on FTTP to new sites within commercial areas.

A14.261 The figure below shows the overall additional capex in the top-down and bottom-up models which results from assuming a 1% household growth. This additional capex is calculated by comparing the total capex with and without the household growth assumption. It shows that our modelling predicts a capex that is lower than in the Openreach NGA business case by [✂] over the charge control period.

Figure A14.8: Additional capex for new sites – £m [✂]

Source: Openreach analysis of Openreach information

A14.262 This capex shortfall, however, does not necessarily translate into a cost recovery problem. Given that an FTTP network tends to live longer than an FTTC network (as it uses relatively more passive infrastructure than electronics, with longer asset lives), the unit cost required to recover the initial investment could be lower for FTTP than for FTTC, as the total capex required would be recovered over a longer time period.

A14.263 We have tested this by spreading Openreach's estimated FTTP capex over a 20-year period (i.e. implying a 20-year average lifetime for FTTP assets). We have then compared these costs against the additional CCA costs produced by the top-down and bottom-up models due to our household and business growth assumptions. The results of this comparison are presented in the figure below. It shows that the additional CCA costs predicted by our models sit above the additional CCA costs implied by Openreach's FTTP investments spread over this asset life period; suggesting no cost under-recovery problem.

Figure A14.9: Additional total (CCA) costs for new sites – £m [✂]

Source: Ofcom analysis of Openreach information

A14.264 This raises the question, however, of whether we should allow Openreach to over-recover costs. The figure above shows that our modelling would allow Openreach to recover more than its FTTP costs in new sites.

A14.265 We note that the Openreach business case assumes a lower number of new sites than our volume forecasts, which could partly explain why our modelling predicts higher costs than Opereach's FTTP cost estimates would suggest. We discuss our approach to volume forecasts in Annex 10.

A14.266 Another factor that could explain a possible over recovery is FTTP being a more cost-effective solution than FTTC to deliver the controlled GEA 40/10 service (either because is cheaper to deploy or because it has a longer asset life than FTTC). This goes back to our choice of applying an anchor pricing approach by basing the controlled GEA 40/10 charge on the costs of FTTC. As already explained, we would expect this approach to encourage operators to deploy new technologies which allow them to offer similar services but at a lower cost and/or higher quality.

A14.267 In this instance Openreach is choosing to use FTTP to supply fibre services to new sites. If FTTP turns out to be more cost effective than FTTC to deliver fibre to these premises, allowing Openreach to keep the cost difference would be consistent with our anchor technology approach. Therefore, as proposed in our March consultation, we have decided to base the costs of the additional fibre volumes from new sites on the costs of a FTTC overlay network and have not made any adjustments to our modelling in this case.

Cost of capital

A14.268 As proposed in our March consultation, we have decided to use the "Other UK telecoms" WACC to determine the cost of capital for the modelled network. In Annex 20 we set out our approach to calculating the WACC for the review period. We have determined an "Other UK telecoms" WACC of 9.0% for 2019/20 and 8.9% for 2020/21.

A14.269 In our bottom-up model we have used the 2019/20 WACC value for the period 2017/18 to 2019/20, and the 2020/21 WACC over the period beyond 2020/21.[381] Accordingly, we have updated the bottom-up model with our decision on WACC.

[381] No stakeholder commented on this element of our proposals.

A15. Bottom-up model: calibration

A15.1 As outlined in Section 4, we have calibrated the bottom-up model to ensure that the intermediate and final outputs are reasonably in line with a real-world network deployment and cost. As a result of this calibration, we have made some adjustments to our model inputs and network design parameters where appropriate.

A15.2 In summary, we have sought to calibrate the bottom-up model against data for as many years as we have available. We have received actual asset count and cost information from BT and Openreach for the following years, which we have used in our calibration:

a) 2015/16 and 2016/17 for asset counts;

b) 2014/15, 2015/16 and 2016/17 for attributed costs; and

c) 2010/11 to 2016/17 for actual spend.

A15.3 We have used a two-stage approach to our model calibration:

- **Stage 1** (asset count calibration): we have compared the number of network elements dimensioned by the bottom-up model against BT's asset count information.
- **Stage 2** (cost calibration): we have compared the model against a range of BT cost metrics (i.e. Gross Replacement Costs (GRC), Net Replacement Costs (NRC), opex, capex and total CCA costs).

A15.4 As a final cross-check, we have compared the combined MPF and GEA 40/10 unit LRIC+ produced by the bottom-up and top-down models against comparable access prices in other European countries. We have not, however, calibrated the model against European price benchmarks.

A15.5 In this annex, we discuss our general approach to calibration and then discuss details of our two-stage approach to model calibration (and finally our international comparison cross check). For each sub-section in turn, we discuss our consultation proposals, a summary of stakeholder responses and details of our reasoning and decisions.

Approach to bottom-up model calibration

A15.6 When developing a bottom-up model we consider it desirable to verify the reasonableness of the model outputs. When we have built bottom-up models in the past we have calibrated the outputs against actual real-world data wherever possible.[382] In this subsection we lay out the approach we have taken to calibrating the bottom-up model in this review including:

- Comparison Network;
- Data sources;
- Calibration period; and

[382] See, for example, 2015 MCT Statement, Annex 9 and 2013 NMR Statement, Annex 6.

- Sequencing of calibration.

Comparison Network

Our proposals

A15.7 In our March consultation we proposed to verify the reasonableness of the outputs of the bottom-up model against asset count and cost information from Openreach's commercial FTTC deployment. We said that this was appropriate given our modelling of the costs of a national efficient FTTC operator, calculated as an overlay to an existing copper network.

Stakeholder responses

A15.8 Only Vodafone commented on this issue. It stated that "in the case of a fibre FTTC bottom-up model it would seem that there would be various sources of actual data and models that could be referenced and benchmarked against".[383] It said that "other operators have rolled out actual networks in the UK, BT have submitted business plans in connection with the BDUK government funding schemes, as have other operators, and these networks have been rolled out in many countries with similar geographic characteristics as the UK".

A15.9 Vodafone went on to say that "Ofcom's modelling methodology whereby the network design, network costs, and various additional and overhead costs are sourced and based almost exclusively on BT's costing data means the risk that the calculated result includes significant errors is extremely high and asymmetric".[384]

Our reasoning and decisions

A15.10 As set out in Annex 14, our conceptual approach aims to model the costs of an efficient FTTC overlay network. In doing so we have used Openreach's copper network (excluding cabinets in subsidised areas) as the starting point of our modelling exercise. The network that is closest to the network we are seeking to model is therefore Openreach's commercial FTTC network. Consequently, we have used this network as the reference to calibrate our model against.

A15.11 We have also assessed whether calibrating the bottom-up model outputs against networks other than Openreach's would be appropriate. We consider that, apart from Openreach, no other UK telecoms provider has deployed a FTTC network with similar characteristics in terms of scale and technology. Therefore, we believe that it would be inappropriate to calibrate our model outputs against other UK networks.

A15.12 We have also considered comparing the outputs of our modelling against network costs in other European countries. As noted in our March consultation, we believe that any international comparisons need to be treated with care as conditions underpinning fibre network deployments tend to vary from country to country. This means that any cross-country comparison would not be like for like. On this basis we do not consider it

[383] Vodafone response to the March 2017 WLA Consultation, paragraph 12.3.
[384] Vodafone response to the March 2017 WLA Consultation, paragraph 12.3.

appropriate to calibrate the bottom-up model against networks built outside the UK. However, as a cross-check, we have compared our estimated MPF + GEA 40/10 LRIC+ against the charges set in other European countries as set out later in this annex.

Data sources

Our proposals

A15.13 In our March consultation we proposed to use the following BT and Openreach data sources to inform our model calibration:

- BT's physical asset inventory ('BT actual asset count');
- BT's Management Accounts;
- BT's RFS; and
- The Openreach Model, as discussed in Annex 14.

Stakeholder responses

A15.14 Openreach, Virgin Media and Vodafone commented on this proposal.

A15.15 Openreach was of the view that "the focus of any calibration exercise should be against the latest Openreach business case" as their concern with our modelling approach related to the forward-looking assumptions about the costs of supply.[385]

A15.16 Virgin Media supported "the appropriate weight applied to BT's actual cost data".[386] However, it was concerned that before calibration the model consistently and significantly underestimated actuals, and the outputs from BT's in-house models.

A15.17 Vodafone on the other hand was concerned about "significant weight [being] placed on the information contained within [BT] data sources and would like to ensure that the information has been audited and cross-checked to a level in-line with its importance in determining GEA prices".[387] Specifically Vodafone asked the following questions about the BT data sources used:

a) What level of audit, third party validation has the data source been subject to?

b) What BT internal compliance processes were in place when the data was compiled?

c) What cross-checks/validation has Ofcom performed on the data?

A15.18 Vodafone also asked in relation to BT's management accounts whether the information on "BT's capital spend on commercial fibre access has been reconciled to BT's total capital spend and the regulated financial statements". It also asked whether "any spend on BDUK has been specifically segregated and reconciled to the total BDUK capital spend". In relation to the Openreach Model, Vodafone asked how Ofcom ensured that the

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[385] Openreach response to the March 2017 WLA Consultation – Volume 2, paragraph 269.
[386] Virgin Media response to the March 2017 WLA Consultation, paragraph 151.
[387] Vodafone response to the March 2017 WLA Consultation, paragraph 14.4.

information from this source "is accurate and in line with an equally efficient operator and indeed suitable for being used in a calibration process".[388]

Our reasoning and decisions

A15.19 In calibrating our bottom-up model for this statement we have used the sources on which we consulted (and which are discussed above), as well as Openreach's updated business case and Openreach data from our 2016 Connected Nations report.[389] We provide a brief description of each of the data sources and explain how they have been updated since the consultation:

- **BT actual asset count**: BT provided the number of elements in BT's network, including information for FTTC cabinets, exchanges, headend equipment and DSLAM variants. This data was provided for two points in time: March 2016[390] and August 2017.[391]
- **BT's Management Accounts**: BT provided information on its capital spend on its commercial fibre access network for the period from 2010/11 to 2015/16.[392] This was updated to include 2016/17 data after our March consultation.[393] This information was provided with a split by programme and technology (i.e. FTTC/FTTP), allowing us to identify and remove FTTP costs where appropriate.
- **BT's RFS**: BT provided information on the costs allocated to commercial GEA services in the RFS. This information was supplied on a LRIC and FAC basis at a component level and for the years 2014/15, 2015/16.[394] Since our March consultation, this information was updated to 2016/17.[395] The RFS cost information reflects mid-year costs.
- **Openreach Model**: Based on a list of copper cabinets we supplied, Openreach provided the modelled asset count and modelled labour and equipment (stores) costs which result from dimensioning a new FTTC overlay network. These outputs were provided for two network sizes: i) c.48,000 cabinets using network and cost assumptions as at March 2016[396] and ii) c. [✂] cabinets using network and cost assumptions as at August 2017[397], following our March consultation.
- **Openreach business case update:** in response to our March consultation, Openreach supplied the actual and forecast capex and opex associated with its NGA1 and BDUK programmes over the period 2008/09 to 2028/29.[398] This information was provided for four scenarios: 1) pre charge control – national; 2) pre charge control – commercial

[388] Vodafone response to the March 2017 WLA Consultation, paragraph 14.4.
[389] We address Openreach's point about forward-looking information in the next sub-section.
[390] Openreach response dated 6 September 2016 to questions 1, 5, 16, 21 and 23 of the 14th s.135 notice.
[391] Openreach response to questions 2.3, 3.1, 3.2 and 3.3 of the 38th s.135 notice dated 18 September 2017.
[392] Openreach response dated 4 July 2016 to question 7 of the 8th s.135 notice; and Openreach response dated 20 September 2016 to question 9 of the 14th s.135 notice.
[393] Openreach response to question 2.10 of the 38th s.135 notice dated 19 September 2017.
[394] Openreach response dated 19 February 2016 to question 3 of the 3rd s.135 notice; Openreach response dated 25 November 2016 to questions 3, 6 and 15 of the 19th s.135 notice; Openreach response dated 20 February 2017 to question 1 of the 24th s.135 notice; Openreach response to the 34th s.135 notice dated 16 August 2017; and AFIs provided alongside the 2014/15 and 2015/16 RFS.
[395] Openreach response to the 34th s.135 notice dated 16 August 2017; and AFIs provided alongside the 2016/17 RFS.
[396] Openreach response dated 6 September 2016 to questions 5 to 7 of the 14th s.135 notice.
[397] Openreach response to questions 2.3 and 2.4 of the 38th s.135 notice dated 18 September 2017.
[398] Openreach response dated 22 June 2017 to question 7b of the 1st s.135 notice.

only; 3) post charge control – national; and 4) post charge control – commercial only. For our calibration, we have only considered scenarios 2 and 4.

- **2016 Connected Nations report:** we have used take-up data at a cabinet level from this source to validate some of the data supplied by Openreach. This cabinet data is as of June 2016.

A15.20 Although these sources are the same that we have used to populate the bottom-up model (see Annex 14), the information we have used for our calibration is different. Whereas for populating our model we have relied on more granular information (e.g. unit capex, unit opex), for model calibration we have mainly used aggregated data (e.g. total capex, total opex).

A15.21 Each source above also provides different information about Openreach's FTTC network deployment in terms of the type of data it refers to (whether it is asset count, spend or attributed costs) and the time period the data relates to. We believe that using as much information as is available makes our calibration more robust and allows us to reduce the risk of regulatory gaming, as highlighted in Annex 14. Therefore, rather than calibrating our model against a single source, we have calibrated the model against a range of sources.

A15.22 In verifying the data from the BT and Openreach sources, we identified a number of issues with the comparability of this data with our model outputs. Specifically, we noted that some of the information provided was not consistent with our modelling aim of reflecting commercial/FTTC-only costs. For this reason, where feasible, we have made adjustments to the data from these sources. These adjustments are discussed later in this annex.

A15.23 In response to Vodafone's concerns about the quality and robustness of the data we have used, we note that:

- The information we have relied on from BT and Openreach was obtained using our statutory information gathering powers. As we discuss in Section 4, our formal information requests put a legal duty on recipients to provide accurate and correct information. If the information provided is not accurate, we can take enforcement action, including imposing financial penalties.[399]
- The RFS, and to some extent BT's Management accounts,[400] are audited by a third party.
- We requested that BT and Openreach reconcile the capex and opex in the NGA business case back to its Management Accounts and RFS and they did this to the extent possible.[401]

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[399] As noted in Section 4 in our discussion of information gathering, we recently investigated BT's compliance with a statutory information request as part of the WLA Market Review and imposed a fine on it.

[400] Capex information in the Management Accounts is included in the audit process to the extent that the information feeds into BT's statutory accounts, which is the case for the overall capex at the Openreach level.

[401] For capex, the figures were reconciled to the management accounts. Openreach was also able to reconcile power costs to the RFS. For other opex items, Openreach explained that the costs from the management accounts supplied for our March consultation applied a different methodology to the one applied for the business case and, as a result, could not reconcile the two sources.

Calibration period

A15.24 In general, we are interested in calibrating our model outputs for as many years as data is available. Openreach provided data for the following years which we have used in our model calibration:

- 2015/16 and 2016/17 for asset count;
- 2014/15, 2015/16 and 2016/17 for RFS data; and
- 2010/11 to 2016/17 for actual spend.

A15.25 Openreach's updated business case also provides cost information for the forecast period of the model. Openreach advocated the use of this information for calibration purposes, But we do not consider this to be appropriate. Unlike with outturn data, there are no other sources of evidence we could use to verify the robustness of Openreach's cost forecasts. Where we have been able to validate these forecasts, we have used them to assess the reasonableness of our model inputs, as discussed in Annex 14. We have therefore not used the cost forecasts from the Openreach business case in our model calibration.

Sequencing of calibration

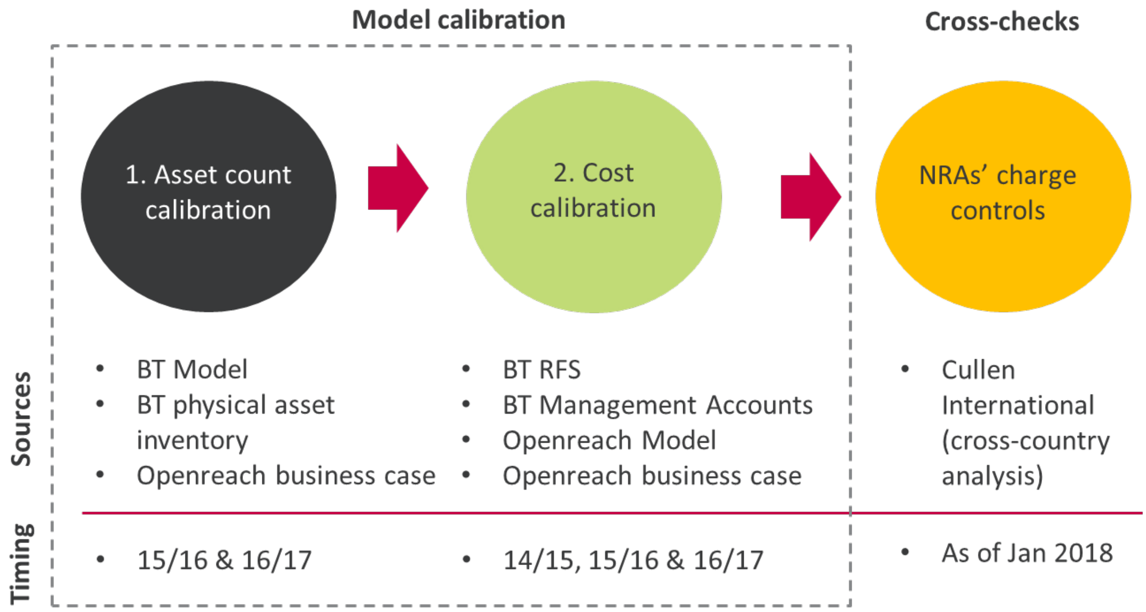
A15.26 We have implemented the model calibration in two stages:

- **Asset count calibration:** we first calibrated the model against BT and Openreach asset count information.
- **Cost calibration:** we then calibrated the model against multiple BT cost metrics including GRC, NRC, cumulative capex, operating costs and total (CCA) costs.

A15.27 As a cross-check, we compared the combined MPF and GEA 40/10 unit LRIC+ resulting from our bottom-up and top-down modelling against comparable access charges in other European countries. However, for avoidance of doubt, we have not used this cross-check for calibration purposes.

A15.28 The calibration process described above and the sources we have used are illustrated in the figure below.

Figure A15.1: Calibration process and sources used



Source: Ofcom

Stage 1: asset count calibration

A15.29 For this stage of calibration, we relied on asset count data from BT's physical network inventory and Openreach Model. The main difference between these two sources is that while BT's physical network inventory provides actual asset count, the Openreach Model provides modelled asset count for a hypothetical FTTC-only network based on Openreach's engineering assumptions, which is closer to the way we model the FTTC network.

A15.30 Given that the asset count from the Openreach Model is more comparable to our model outputs, we have used the Openreach Model as the main source of evidence in our asset count calibration. To improve the robustness of our calibration, we have also considered BT's actual asset count but only for key network elements, as identified in the subsections below.

A15.31 The results of our asset count calibration are described below for key network elements. We have grouped these elements into four categories: exchange, fibre cable, FTTC cabinets and PCP to FTTC cabinets.

A15.32 As a result of this calibration exercise we have made the following adjustments to the coverage drivers and utilisation factors in the bottom-up model:

- Optical line terminations (OLTs): we increased the coverage driver for this element from 1 to [✂];
- OLT northbound cards: we increased the coverage driver for this element from 1 to [✂];
- Optical Cable Rack (OCR) sub-racks: we increased the coverage driver from 1 to [✂] and reduced the utilisation factor from 81% to [✂]; and

- Cable chamber joints: we increased the coverage driver from 1 to [✂].

Exchange

Optical line terminations

Our proposals

A15.33 In our March consultation we found that the outputs of the bottom-up model before calibration understated the number of OLTs in Openreach's commercial FTTC network.

A15.34 We identified three factors that could explain this discrepancy, including Openreach's dual vendor strategy, Openreach's FTTP deployment and the lack of geographic disaggregation in our bottom-up model (i.e. use of national averages).

A15.35 We said that the observed discrepancy was unlikely to be driven wholly by a dual vendor strategy given that Openreach had only implemented dual vendor in 13% of its commercial exchanges. Similarly, we believed that Openreach's FTTP deployment was unlikely to affect the asset count in a material way given its limited scale until now.

A15.36 Using Openreach cabinet and exchange location data, we estimated the number of OLTs that would be required in each Openreach exchange to carry the volumes and bandwidth demand included in our model. We found that our use of national averages appeared to lead to our modelling understating the number of OLTs in the Openreach network for 2028/29, but not for 2015/16. Based on this evidence we proposed to make adjustments to the utilisation factors in the bottom-up model to mirror the results of our more detailed exchange-by-exchange analysis.

Stakeholder responses

A15.37 Only Virgin Media commented on this matter. It said that "the extensive use of national-average information was a concern that Virgin Media raised in response to the [May 2016 consultation on fibre cost modelling]" and rather than remedying this, "Ofcom has lowered the utilisation factor on [OLT and OCR] elements, but not sufficiently to replicate BT's asset counts".[402] Virgin Media raised the concern that a limitation of the model was not corrected, and that the model still underestimates the number of network elements.

Our reasoning and decisions

A15.38 In our March consultation, we carried out our exchange by exchange analysis assuming that the level of take up in each cabinet is similar to the national average. We have refined this analysis by using take-up data at a cabinet level from the 2016 Connected Nations report. Specifically, we have applied our bandwidth demand forecasts to the take-up observed in each cabinet to work out the number of backhaul links required at each Openreach FTTC cabinet. We have then used these calculations to derive the number of OLTs required at each Openreach exchange, based on the capacity rules used in our modelling.

[402] Virgin Media response to the March 2017 WLA Consultation, paragraph 152.

A15.39 In calculating the number of OLTs required we have considered whether a particular exchange uses dual vendors and thus whether it would require a minimum of two OLTs to serve the connected cabinets. We have also factored in the different equipment capacities in the Openreach network depending on the vendor used.

A15.40 This analysis indicates that, on average, each commercial exchange requires [✂] (~1.32) based on the bandwidth demand (in the busy hour) observed in 2016/17. This is lower than the average number of OLTs per exchange in the Openreach network which is around [✂] (1.5-2), but higher than what we assumed in our March consultation (i.e. one OLT per exchange).

A15.41 We have examined whether this result changes once we factor in the growth in the number of FTTC customers and bandwidth demand expected over the charge control period. To assess this, we have taken into account our volume and bandwidth demand forecasts to 2020/21. This suggests a slightly higher average number of OLTs required per exchange of [✂] (~1.35).

A15.42 On the basis that the modelled network should be able to support the volume forecasts included in our model for the charge control period we have adjusted the coverage drivers in the bottom-up model to assume a minimum of [✂] (~1.35) OLTs per exchange.

OLT southbound cards

A15.43 As in our March consultation, we found that the bottom-up model (before calibration) understated the number of OLT southbound cards in the Openreach Model (we did not request actual figures for this element).

A15.44 As part of the 2016/17 data refresh, Openreach did not provide a modelled asset count from the Openreach Model for this network element. It explained that the new version of the Openreach Model no longer reports the count of southbound cards as it uses the number of ports as the basis for calculating costs. In the absence of this data, we have estimated this count by dividing the total number of ports – dimensioned in the Openreach Model – by the port capacity of a southbound card (less the number of ports left spare) as per the assumptions in the Openreach Model (i.e. [✂] (~13) ports).

A15.45 The estimated count is higher than in our bottom-up model but reduces once it is adjusted by the number of OLTs (as the Openreach Model assumes a higher number of OLTs than our modelling).[403]

A15.46 The lower adjusted count in the Openreach Model can be explained by our model factoring in Openreach's dual vendor strategy, as opposed to the [✂]. This means that whilst our modelling assumes a blended capacity of [✂] ports per card, the Openreach Model assumes [✂] (~22). Once these differences are accounted for (i.e. number of OLTs per exchange and different element capacities), the number of southbound cards in the two

[403] The number of southbound cards per OLT implied in the Openreach Model is [✂] (~2.7), whilst in the bottom-up model it is 3.9.

models is reasonably similar. We have therefore not made changes to our modelling in this case.

OLT northbound cards

A15.47 In our March consultation we found that the asset count produced by our model for OLT northbound cards was in line with the outputs of the Openreach Model. Since our March consultation, we have received further information from Openreach which suggests that our modelling could understate the actual number of northbound cards in the Openreach network. This is because the Openreach Model, as well as our March consultation models, do not take account of network interconnection.

A15.48 To address this point, we have considered the outputs of Openreach's Capacity Model, which is an overlay to the Openreach Model. This overlay model dimensions the number of network elements required in the Openreach Model to meet the current and expected demand for NGA services. In particular, we have looked at the number of northbound cards calculated by this model for the same network footprint as our modelled network.

A15.49 Our analysis of the Openreach Capacity Model suggests that there are [✂] (2-3) northbound cards per OLT. In comparison, the Openreach Model and our model (before calibration) assume one card per OLT. We believe that this discrepancy is explained by the latter models not capturing the fact that multiple telecom providers seek access to the Openreach network. Specifically, the Openreach Capacity Model assumes that at least [✂] (3-8) telecom providers (including BT retail) can be supported at each exchange.

A15.50 Consistent with the Openreach Model, our bottom-up model assumes that each northbound card has a capacity of eight gigabit ethernet (GE) ports with two ports left spare: one for network operation purposes and another for multicast. This means that, in order to support access from [✂] (3-8) telecom providers, only [✂] (1GE – 2GE) port(s) per card would be available to each telecom provider. It is therefore likely that more than one northbound card will be necessary in each OLT. To account for this in our modelling, and given that northbound cards account for only 0.5% of the modelled network's total capex, we have made the simplifying assumption that a minimum of [✂] northbound card(s) are required per OLT, which is consistent with the asset count in the Openreach Capacity Model.

Optical Cable Racks and OCR sub-racks

A15.51 In our March consultation we found that our bottom-up model predicted a lower OCR count than the Openreach Model. We explained this was likely due to our use of national averages and proposed to adjust the utilisation factors in our model to address this. To inform this adjustment we looked at cabinet and exchange data from Openreach to assess the likely number of GE ports required at each Openreach exchange.

A15.52 We have now refined this analysis by using the 2016 Connected Nations data which contains fibre take-up at a cabinet level. Specifically, we have applied our bandwidth demand and take-up forecasts to this data to work out the capacity required at each

Openreach exchange, in a similar way as we did for OLTs. We have then applied the following planning rules, which are used in the Openreach Model as well as in our bottom-up model, to derive the number of OCRs and OCR sub-racks required:

- OCR: eight sub-racks per OCR.
- OCR sub-rack: 72 fibres per sub-rack.

A15.53 This suggests that, on average, a single OCR and [✂] (~1.34) sub-racks are needed per exchange.

A15.54 We have analysed whether these results change once we factor in the volumes and bandwidth demand expected by 2020/21. The number of OCRs remain at one per exchange, but the number of sub-racks required would increase to [✂] (~1.39).

A15.55 These results are consistent with our pre-calibration bottom-up modelling for OCRs, but not for OCR sub-racks. Our bottom-up model predicts [✂] (~1.05) OCR sub-racks per exchange are needed for 2016/17 and [✂] (~1.26) sub-racks per exchange for 2020/21.

A15.56 We consider that our modelling ought to capture the variations in demand characteristics observed across exchanges where these variations have a material impact on our model inputs – otherwise we would risk understating real-world costs. Therefore, we have adjusted the parameters in the bottom-up model to mirror the results of our exchange-by-exchange analysis for OCR sub-racks. Namely, we have increased the coverage driver for OCR sub-racks from one to [✂] (~1.34), and reduced the utilisation factor associated with this element from 81% to [✂] so that the number of sub-racks per exchange in the model by 2020/21 is [✂] (~1.39), bringing our model outputs more in line with Openreach's actuals.

OLT to OCR tie cables

A15.57 As in our March consultation, we found that the number of OLT to OCR tie cables (i.e. Hydra cable) dimensioned in the bottom-up model before calibration is lower than the modelled asset count in the Openreach Model.

A15.58 Openreach did not provide a modelled asset count for 2016/17 for the same reasons as outlined above for other exchange elements. Given that the number of OLT to OCR tie cables is partly driven by the number of DSLAMs, we compared the DSLAM to OLT/OCR tie cable ratio implied in the two models. In our March consultation we found that this ratio was higher in our bottom-up model (compared to the Openreach Model) but said that we could not explain this discrepancy since the two models appeared to be using the same engineering rules.

A15.59 This continues to be the case. The DSLAM to OLT/OCR tie cable ratio in the bottom-up model is 10, while in the Openreach Model is ([✂] (~9.5)). We believe that this could be explained by the larger number of OLTs assumed in the Openreach Model. Once we account for the OLT count, the DSLAM to OLT/OCR ratio looks more similar across the two models, with the difference being less than one.

A15.60 We remain of the view that the planning rules used in the Openreach Model and in our modelling are reasonable and consistent with the guidelines set out by equipment manufacturers. We consider that we have implemented these rules correctly in our model. Consequently, we have made no further changes to our modelling in this case.

Chamber Cable Joints

Our proposals

A15.61 In our March consultation we found that, before calibration, the bottom-up model produced fewer Chamber Cable Joints (CCJs)[404] than the Openreach Model. We said that the use of national averages in the bottom-up model could explain this discrepancy. To investigate this, we looked at the expected number of backhaul fibre cables required at each exchange.[405] This analysis suggested a lower number of CCJs than estimated in the Openreach Model for 2015/16, but higher than assumed in the bottom-up model for 2028/29. We therefore proposed to adjust the utilisation factor associated with this element in the bottom-up model to mirror the number of CCJs suggested by our more detailed exchange-by-exchange analysis.

Stakeholder responses

A15.62 Only Vodafone commented on this matter. It noted that "Ofcom appears to have generated asset counts consistent with BT's planning and capacity rules but it still underestimates [BT's] asset count".[406] It argued that rather than reflecting a more efficient outcome, our analysis reflects more likely the use of national averages.

Our reasoning and decisions

A15.63 We have refined our exchange-by-exchange analysis by using take-up data at the cabinet level from the 2016 Connected Nations report. We continue to find that the expected number of CCJs required (following the planning rules used in the Openreach Model and our bandwidth demand forecasts in the bottom-up model) is lower than the modelled asset count in the Openreach Model.

A15.64 Yet, the number of CCJs suggested by our refined analysis is slightly higher than in our updated model before calibration. For 2016/17, we estimate that the number of CCJs required per exchange is on average 1.03, while for 2020/21 this number increases marginally to 1.04. In comparison, the model, before calibration, assumes one CCJ per exchange for the same years.

A15.65 We consider that it is appropriate for the bottom-up model to reflect the variation in demand characteristics across exchange areas. To account for this, and given the low variation in the number of CCJs required per exchange between years, we have adjusted our modelling to assume a minimum of 1.04 CCJs per exchange.

[404] CCJs are needed to aggregate the fibre cables connecting the DSLAMs with the exchange.
[405] Each CCJ can aggregate up to 144 fibre cables.
[406] Vodafone response to the March 2017 WLA Consultation, paragraph 152.

A15.66 We acknowledge that this is still lower than the 1.4 CCJs per exchange assumed in the Openreach Model. This is despite using the same planning rule maximum of 144 fibres per CCJ. Openreach did not comment on this in response to our March consultation, so we have not received further evidence that would shed light on the observed discrepancy. Therefore, we remain of the view that the results of our exchange by exchange analysis above are consistent with the deployment of an efficient FTTC network. For this reason, we have not calibrated our model to Openreach's modelled asset count in this case.

A15.67 Figure A15.2 below compares the asset count for exchange elements between the bottom-up model and the BT and Openreach sources, after calibration.

Figure A15.2: Asset count comparison for key exchange elements after calibration [✂]

Source: Ofcom, using BT and Openreach information

Fibre cable

A15.68 In our March consultation, our analysis showed discrepancies in the distribution of fibre cable types between the bottom-up model and the Openreach Model. Compared to the Openreach Model, the estimated total cable length in the bottom-up model was longer for thinner four-fibre cables, and shorter for thicker fibre cables. On aggregate, however, we found that the outputs of the two models appeared reasonably aligned. We found a similar result in the updated model, before calibration (see Figure A15.3).

Figure A15.3: Asset count comparison for fibre cable types after calibration, millions of km, 2016/17 [✂]

Source: Ofcom, using BT and Openreach information

A15.69 In our March consultation, we explained that fibre cable length in the bottom-up model is informed by Cartesian's geospatial analysis of cabinet and exchange location data.

A15.70 We said that we considered this approach to be transparent and flexible as it enables us to easily update the cable length in the bottom-up model, if we were to find it appropriate in future updates to the model, to change the scale and coverage of the modelled network by simply re-running the geospatial analysis.

A15.71 We also assessed whether the observed gaps at a cable type level could lead to over or under estimating Openreach's fibre cable costs. As shown in our Network Cost model, different cable types have different unit costs. Despite this, we found that the unit cost of a four-fibre cable was similar to the weighted average unit cost of thicker cables. We therefore said that we expected the cost discrepancies for thinner and thicker cables to cancel each other out.[407]

A15.72 Given that the unit costs in the bottom-up model for fibre cable have not materially changed since our March consultation, we continue to believe that the observed asset

[407] Whereas the per metre cost of a four-fibre cable is [✂] (~£2.70), the weighted average cost of thicker cables is [✂] (~£2.60). Note that these costs include cable, sub-duct and installation costs, as well as blown fibre tube cable costs in the case of the four-fibre cable.

count discrepancies at a cable-type level between our model and the Openreach Model will not result in a material under- or over-statement of the costs of an efficient FTTC network. We have verified this in our cost calibration below, which confirms that our cost outputs are in line with Openreach's costs. Therefore, we have decided not to modify the bottom-up model in this case.

FTTC cabinets

A15.73 In our March consultation we identified discrepancies between our model outputs and the asset count from the Openreach Model. We explained that these discrepancies were likely driven by the Openreach Model assuming a higher proportion of small FTTC Cabinets (i.e. Type 1 cabinets) than our bottom-up model. This discrepancy, however, has been removed almost in its entirety in the 2016/17 data refresh supplied by Openreach (see Figure A15.4). Consequently, we consider that the element count at a cabinet type level is now reasonably aligned between the two models. We have therefore decided not to modify our bottom-up model in this case.

A15.74 As in our March consultation, we did not request Openreach to provide actual asset count data for DSLAM access cards. As previously explained, we have based our asset count calibration on the outputs from the Openreach Model (which we consider better reflects an FTTC-only network than BT's actual NGA deployment) and have only requested actuals for key network elements which drive the majority of costs, such as DSLAMs and OLTs as a cross-check.

Figure A15.4: Asset count comparison for key FTTC Cabinet element asset counts after calibration [✂]

Source: Ofcom, using BT information

PCP to FTTC cabinet

A15.75 The bottom-up model produces an asset count that is consistent with the Openreach Model for PCP/copper elements for 2016/17 (see Figure A15.5). This is not the case for 2015/16, where the Openreach Model suggests a longer total copper tie cable length for small (type 1) cabinets and a shorter length for large (type 2) cabinets.

A15.76 Similar to FTTC cabinets, in our March consultation we explained that this discrepancy was a result of the Openreach Model assuming a higher proportion of small cabinets. As noted above, this has now been corrected by Openreach in the 2016/17 data refresh. Therefore, we consider that our modelled asset count is well calibrated against the Openreach model for PCP/copper elements and have thus decided to make no further changes to our modelling in this case.

Figure A15.5: Asset count comparison for key PCP to FTTC Cabinet elements after calibration, millions of metres [✂]

Source: Ofcom, using BT information

Stage 2: cost calibration

A15.77 Having calibrated the bottom-up model based on asset count, we then calibrated the bottom-up model against BT's costs. In doing so we considered the following cost metrics:

- GRC;
- NRC;
- cumulative capital spend;
- annual operating costs; and
- total CCA costs per annum.

A15.78 Figure A15.6 illustrates the combinations of data sources and cost metrics used in our cost calibration. Where multiple sources were available, we compared our model outputs against a range of data points.

Figure A15.6: Combination of cost metrics and data sources

	RFS LRIC	RFS FAC	Management Accounts	Openreach Model	Openreach business case
GRC	✓	✓		✓	
NRC	✓	✓			
Cumulative capex			✓		✓
Operating costs	✓	✓	✓		✓
Total CCA costs	✓	✓			

Source: Ofcom

A15.79 In the remainder of this sub-section we discuss the data sources we have used, the level of cost aggregation of the relevant cost metrics, and the adjustments we have applied to the underlying data to ensure a like for like comparison across the various sources. We then present the cost calibration results.

Data sources

Our proposals

A15.80 In our March consultation we proposed to put equal weight on BT's LRIC and FAC figures from the RFS. This was despite our bottom-up model being a LRIC model. We explained that this was because the RFS LRIC was significantly lower than the LRIC from the Openreach Model, which is also a LRIC model.[408]

A15.81 We also proposed to give less weight to BT's actual operating spend coming from the Management Accounts. We explained that these costs appeared to exclude relevant incremental overheads, such as incremental general management costs.

A15.82 We further proposed to place a different weight on different cost metrics. We explained that, in response to our May 2016 consultation on fibre cost modelling, BT stressed that the RFS costs may "not necessarily account for the relative aging of assets",[409] which we expected to affect mainly the NRC and FAC metrics. For this reason, we proposed to give less weight to the NRC and FAC from the RFS, relative to the GRC and capex metrics.

Stakeholder responses

A15.83 Vodafone noted that although we gave equal weight to BT's LRIC and FAC figures, "the model still appears to produce outputs that are lower than BT's RFS for total annual CCA cost and total annual operating costs".[410]

Our reasoning and decisions

A15.84 We remain of the view that we should give equal weight to BT's LRIC and FAC figures from the RFS. This does not mean, however, that if our model outputs fall closer to the BT LRIC than to the BT FAC we would seek to recalibrate our modelling. Instead, we have assessed whether the outputs of the bottom-up model fall within a reasonable range from the data sources queried. In particular, we would expect our LRIC estimate to sit above the BT LRIC but below the BT FAC. As our results in paragraphs A15.98 to A15.116 show, this was the case for most of the cost comparisons conducted.

A15.85 As proposed in our March consultation, we have also placed less weight on the NRC and FAC metrics in calibrating our model. This is not only because of the issue arising from the relative aging of assets not being properly accounted for in the RFS, but also because of the adjustments we have made to DSLAM asset lives and DSLAM asset prices which also distort the comparability between our model and the RFS for these cost metrics.

Cost aggregation level

A15.86 For each cost metric, we have considered two cost aggregation levels:

- super-component costs: which aggregate the costs of network elements up to more trackable components, i.e. exchange, E-side, FTTC Cabinet, PCP/copper and Other; and
- total costs: which is the sum of all super-component costs.

[408] The only exception being for the 'Other' super-component, for which we knew the Openreach Model does not capture incremental OSS/BSS costs.
[409] BT's response to May 2016 WLA Consultation on fibre cost modelling, paragraph 103.
[410] Vodafone response to March 2017 WLA Consultation, paragraph 152.

A15.87 While super-component costs allow us to make comparisons at a more granular level, they have the drawback of requiring us to map these costs across the different sources which was not always possible. For example, some cost components in the RFS (such as FTTC Repairs and OR Service Centre – Assurance NGA) overlap with two or more super-components. In these instances, we have apportioned the costs to the super-component which was expected to drive the majority of the underlying costs.

A15.88 For this reason, we would expect the comparisons at a super-component level to be less reliable than at an aggregate level; hence we have given less weight to the comparisons at a super-component level.

Cost adjustments

A15.89 As part of our calibration exercise we have ensured only relevant costs are contained in our analysis. We identified some costs which were not appropriate to include in our model calibration, either because they are outside the scope of our cost modelling (such as customer modem duct and non-FTTC costs) or because they are not comparable to way we have treated or measured these costs (e.g. cumulo, provision costs).

A15.90 We set out how we have carried out these adjustments in turn below.

General adjustments - exclusion of customer modem, duct, cumulo and provision costs

A15.91 As proposed in our March consultation we have conducted our cost calibration after excluding duct and provision costs. This is because:

- incremental duct costs are not explicitly modelled in the bottom-up model but are instead added later to our modelling as a top-down allocation; and
- provision costs are treated differently in our model compared to BT's accounting. In particular, provision costs are modelled as operating costs in the bottom-up model, whereas they are partly capitalised in the RFS.[411]

A15.92 In addition, where relevant, we have excluded customer modem costs from the BT and Openreach data sources. This is consistent with the relevant scope of the modelled FTTC network set out in Annex 14. We have also excluded cumulo costs from our annual operating cost comparisons to avoid the different methodological approaches used to estimate cumulo from affecting our calibration. Our approach to estimating cumulo and its allocation to GEA services is discussed in Annex 21.

Specific adjustments to RFS data

A15.93 In reviewing BT's RFS data for our March consultation, as well as for the Statement, we noticed that the following costs were misallocated to, and across, GEA components.

- Megastream service: BT clarified that these costs ([✂] (~£5.7m)) are business connectivity related. We have removed these costs from our cost calibration.

[411] Openreach response to actions raised on 14 July 2016 as a follow-up to the response to the 8th s.135 notice.

- Electricity costs: BT confirmed that cabinet electricity costs were misallocated to NGA E-side Copper Capital - we have therefore reallocated these costs to GEA DSLAM & Cabinets in the RFS.

A15.94 In addition, we have added [✂] (~£31.5m) of general management costs which are allocated to provisions-related components in the RFS. This is because, in our bottom-up model, we have allocated all incremental general management costs to GEA rental services, so for our model outputs to be comparable to the RFS costs we have added back these provisions-related costs to the RFS costs included in our calibration.

A15.95 The net impact of these adjustments is to increase the 2016/17 RFS annual operating costs allocated to GEA rentals by [✂] (~£25.8m).

Specific adjustments to Openreach Model

A15.96 As previously mentioned, the Openreach Model excludes relevant incremental costs related to OSS/BSS systems. In order to make the outputs of the Openreach Model comparable to our model outputs, we have therefore uplifted the costs in the Openreach Model by an amount equivalent to our estimate of incremental OSS/BSS costs.

Specific adjustments to Openreach business case

A15.97 In examining the Openreach business case we found the following two issues:

- Openreach confirmed that incremental general management costs, SLG payments and OSS/BSS operating costs were missing in its business case.[412] To enable like for like comparisons, we have constructed an equivalent output from the bottom-up model which excludes these costs. This adjustment is only relevant for our annual operating cost comparisons.
- We identified around [✂] (~£50m - £100m) capex (over the period 2008/09 to 2014/15) as FTTP specific. We have excluded these costs from our cost comparisons.

Cost calibration results

Gross Replacement Costs

A15.98 Our GRC estimate appears reasonably in line with BT's costs at the total and super-component levels. This is the case for all the years under consideration. In particular, our modelled GRC seems to match [✂].

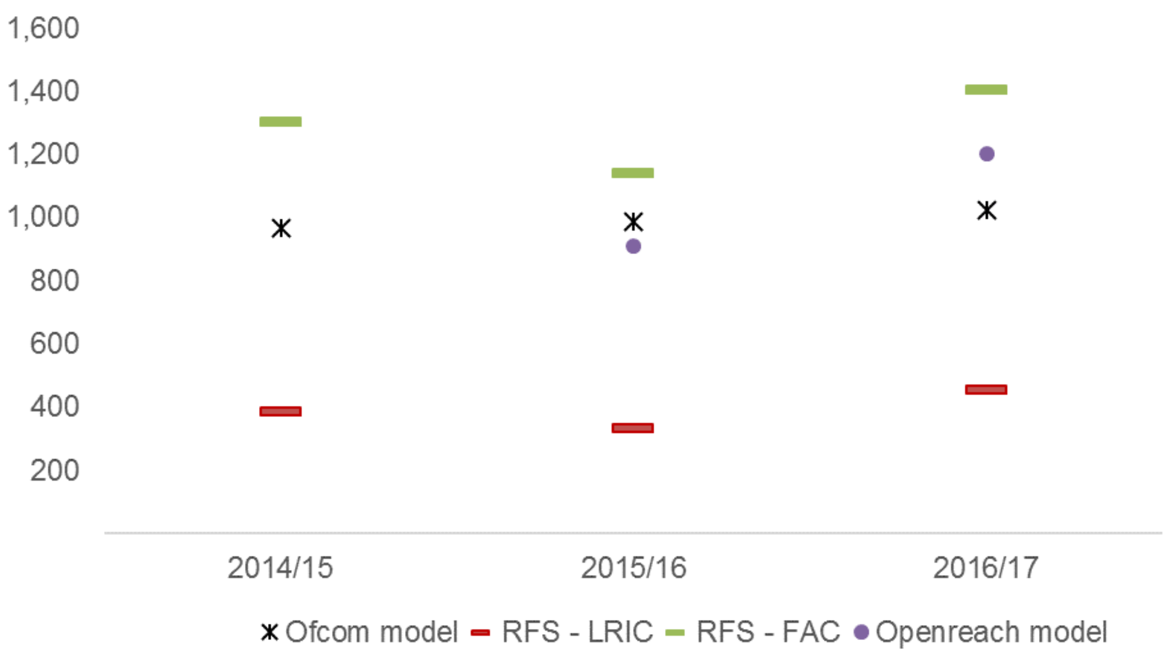
A15.99 As expected, our modelled GRC falls between the BT LRIC and BT FAC from the RFS. We note that the jump observed in the BT FAC between 2015/16 and 2016/17 is not mirrored by our bottom-up modelling. The evidence we have suggests this could be driven by a common cost reallocation rather than by a movement in the underlying incremental cost/investment. As shown in Figure A15.9, whilst the cumulative FTTC capex, as per BT's

[412] Openreach response to questions 9 and 11 of the 42nd s.135 notice dated 7 December 2017; and Openreach response to question 22c of the 25th s.135 notice dated 9 January 2018.

Management Accounts, increased by [✂] between 2015/16 and 2016/17, the BT FAC from the RFS increased by [✂]. This means that the jump in the RFS cannot be explained by new investments, hence leaving a common cost reallocation from copper to fibre as the only plausible explanation. This is further supported by the BT LRIC from the RFS which suggests that the underlying incremental costs remained relatively flat over the same period.

A15.100 Therefore, we believe the GRC is well calibrated and no further adjustments are necessary. The GRC comparisons at the total cost level are presented in Figure A15.7 below.

Figure A15.7: Total GRC, 2014/15 to 2016/17, £m [✂] (Randomised figures)



Source: Ofcom, using BT/Openreach information

Net Replacement Costs

A15.101 Our modelled NRC seems to be on the high-side when compared to the BT LRIC and FAC from the RFS. As illustrated in Figure A15.8, our modelled NRC is slightly above the BT FAC for 2014/15 and 2015/16, but below it for 2016/17. This could be explained by a number of factors.

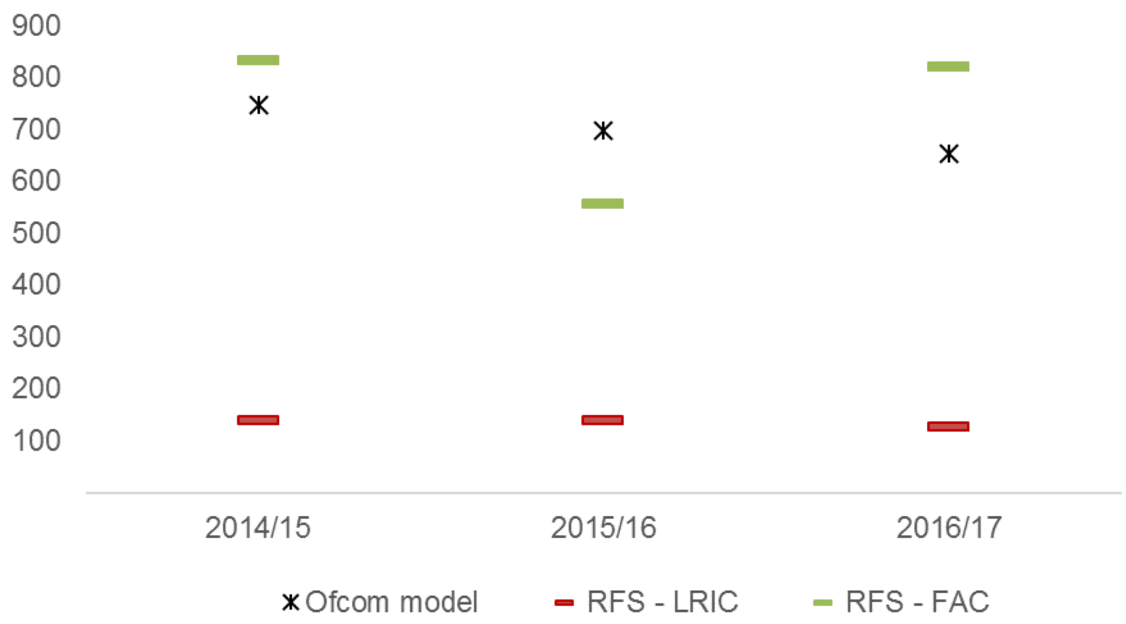
A15.102 As already highlighted, the NRC figures in the RFS are distorted by the pooling of fibre and copper assets when determining the relative age of these assets. Given that copper assets tend to be older than fibre assets, we believe that such asset pooling is likely to lead to fibre assets which are more depreciated than they actually are, and thus to a lower NRC.

A15.103 The higher NRC in the bottom-up model could also be explained by our modelling assuming a longer asset life for DSLAM assets than BT's accounting. This means that DSLAM assets are depreciated less quickly in the bottom-up model than in the RFS, thus resulting in a higher NRC.

A15.104 Another factor, which could explain a higher NRC in our model, is the fact that we assume that more tie cables are installed during the initial phase of network rollout relative to the Openreach network deployment (see paragraph A15.108 for more details). This means that more assets are included in our modelling than in the RFS for the early years of rollout. This gap however should narrow down over time as Openreach adds more tie cables to meet the extra demand.

A15.105 For these reasons, we do not consider our modelled NRC to be strictly comparable to the NRC from the RFS and, on this basis, we have not made any adjustments to our model for this.

Figure A15.8: Total NRC, 2014/15 to 2016/17, £m [✂] (Randomised figures)



Source: Ofcom, using BT/Openreach information

Cumulative capex

A15.106 We found that the bottom-up model produces a cumulative capex that is in line with the cumulative capex from the BT and Openreach sources for 2016/17, but higher for 2014/15 and 2015/16. This is explained by the following factors.

A15.107 First, MEA adjustments applied to years prior to 2016/17 in our bottom-up model – to account for DSLAM line card capacity growth– means that line card costs in the bottom-up model are higher than BT's actual spend for prior years. When undoing these MEA adjustments, the cumulative capex in the bottom-up model drops by £20m, moving it closer to Openreach's actual spend in 2014/15 and 2015/16.

A15.108 Second, Openreach confirmed that it does not install all copper tie cables required to serve the full capacity of a cabinet from Day 1,[413] whereas our bottom-up model does. This

[413] Openreach response to question 1 of our 42nd s.135 notice dated 7 December 2017.

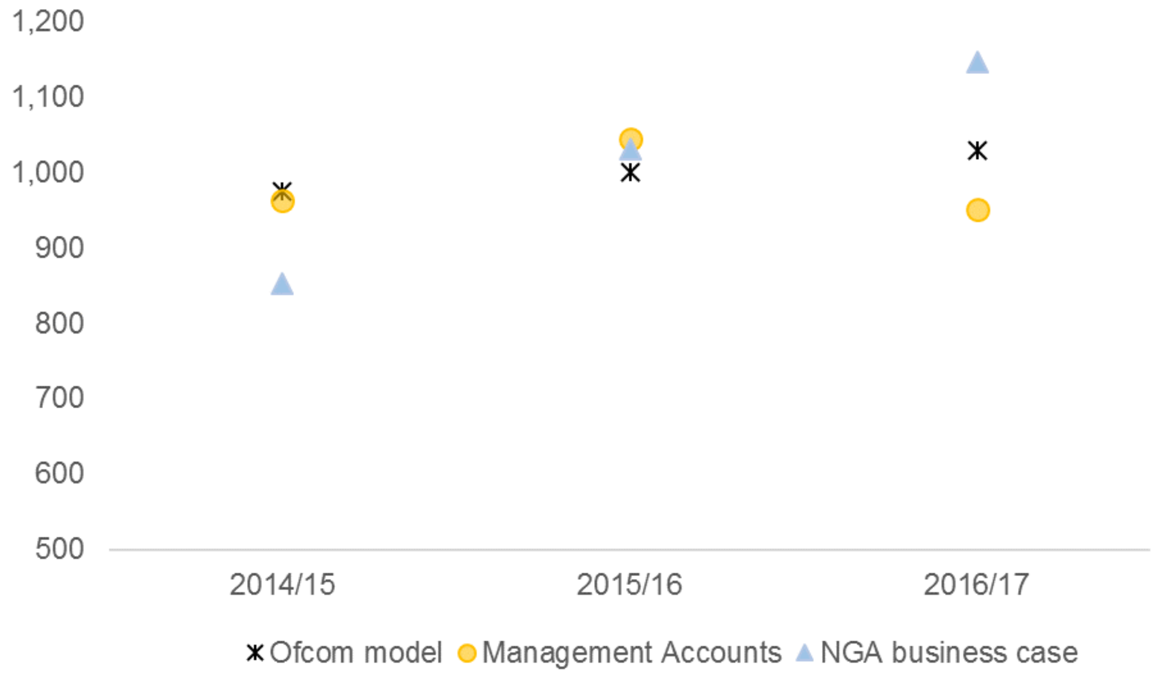
means that, compared to BT's actual spend, the bottom-up model assumes higher capex for the initial years of rollout, and lower capex for later years when take-up of FTTC grows and therefore the need for more tie cables arises.

A15.109 We believe that assuming that all tie cables are installed from the start is reasonable in the context of our anchor technology approach. In a FTTC-only world, we would expect an operator to face higher demand for FTTC services than it would in a world where multiple fibre technologies are deployed (like in the case of Openreach). Therefore, it would seem appropriate to assume that an efficient FTTC-only operator would install the totality of tie cables upfront to avoid sending an engineer back to the cabinet later on as and when more tie cables are needed.

A15.110 Our analysis of BT's Management Accounts indicates that Openreach has spent around [✂] (~£66.3m) to install additional tie cables and uplifting PCP cabinets to accommodate higher FTTC demand, after its initial rollout. This spend accounts for over half the cost gap between our modelled cumulative capex and Openreach's actual spend for the years 2014/15 and 2015/16.

A15.111 Overall, the MEA adjustments in the bottom-up model and Openreach's additional in-life tie cable/PCP spend account for 70% to 90% of the cost discrepancy observed for 2014/15 and 2015/16. Therefore, once these factors are taken into account, it appears that our model is reasonably in line with BT's costs. Consequently, we consider that is not necessary to modify our modelling in this case. The cumulative capex comparisons at the total cost level are presented in Figure A15.9 below.

Figure A15.9: Cumulative capex since 2010/11, 2014/15 to 2016/17, £m [✂] (Randomised figures)



Source: Ofcom, using BT/Openreach information

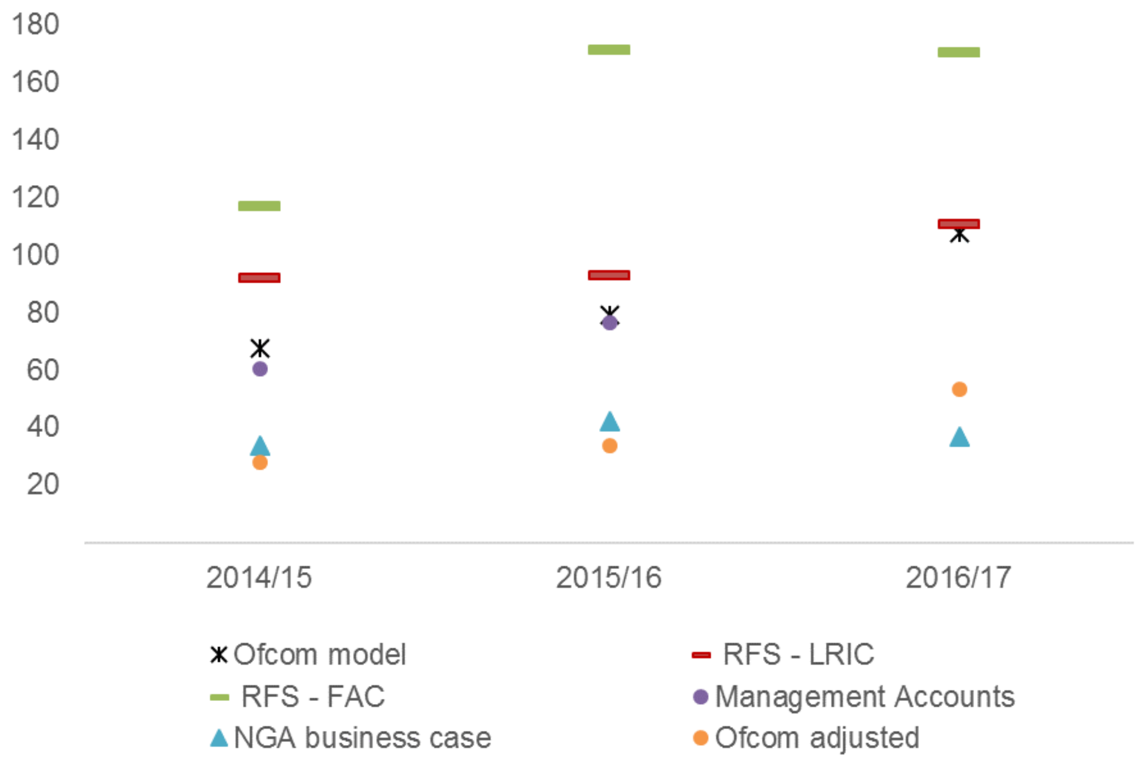
Annual operating costs

A15.112 The outputs of the bottom-up model appear to be within a reasonable range from the costs from the BT and Openreach sources. In particular, the adjusted modelled annual operating costs seem to follow [✂], once the missing costs in the latter are accounted for. We note that these missing costs include incremental general management costs, OSS/BSS costs and SLG payments.

A15.113 When including the missing costs, the modelled annual operating costs appear to be in line with the BT LRIC from the RFS, except for 2014/15 where our model outputs appear significantly lower. This seems to be driven by our modelling assuming a different cost trend than the BT LRIC. While our modelled operating costs grow between 2014/15 and 2015/16, the BT LRIC drops.

A15.114 This discrepancy however does not seem to be caused by a movement in the underlying LRIC as the Openreach business case and Management Accounts also point at the operating costs growing over the same years. We therefore believe that the annual operating costs in the bottom-up model are well calibrated and, consequently, have not made further changes to our modelling. The annual operating cost comparisons at the total cost level are presented in Figure A15.10 below.

Figure A15.10: Annual operating costs, 2014/15 to 2016/17, £m [✂] (Randomised figures)



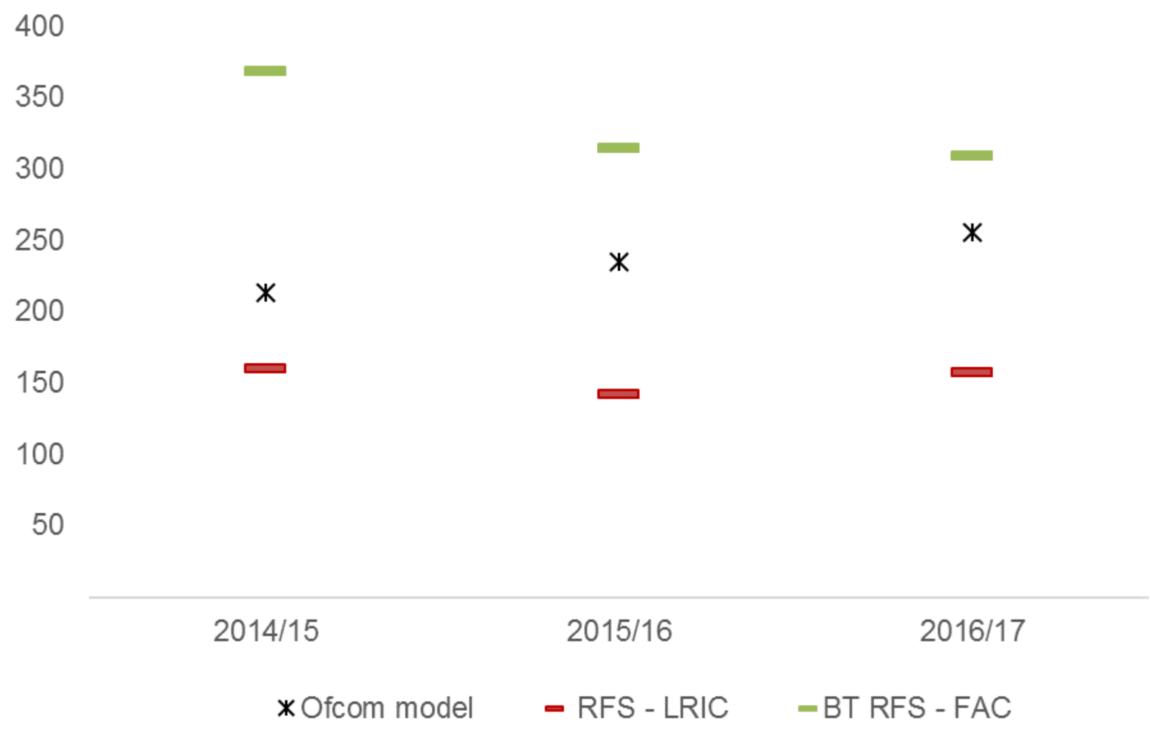
Source: Ofcom, using BT/Openreach information

Total annual costs

A15.115 Finally, our calibration shows that the total (CCA) costs in the bottom-up model are reasonably in line with the costs from the RFS. This is the case at a total cost and super-component level and for all years under consideration.

A15.116 We note, however, that the direction of cost movements in the bottom-up model is different to that in the RFS. Whilst our modelled total costs increase in 2015/16, they fall in the RFS. This seems to be explained by the bump in the annual operating costs and NRC (which in turn drives the return on capital employed) observed in the RFS for the same year. As discussed above, we do not believe that this cost trajectory is reflective of the underlying LRIC of an efficient FTTC operator but instead of the pooling of copper and fibre assets, possible changes in BT's cost attributions and the use of accounting lives (rather than economic lives). Therefore, we consider that the bottom-up model is well calibrated and does not require further adjustments. The total (CCA) cost comparisons at the total cost level are presented in the Figure below.

Figure A15.11: Total (CCA) costs, 2014/15 to 2016/17, £m [✂] (Randomised figures)



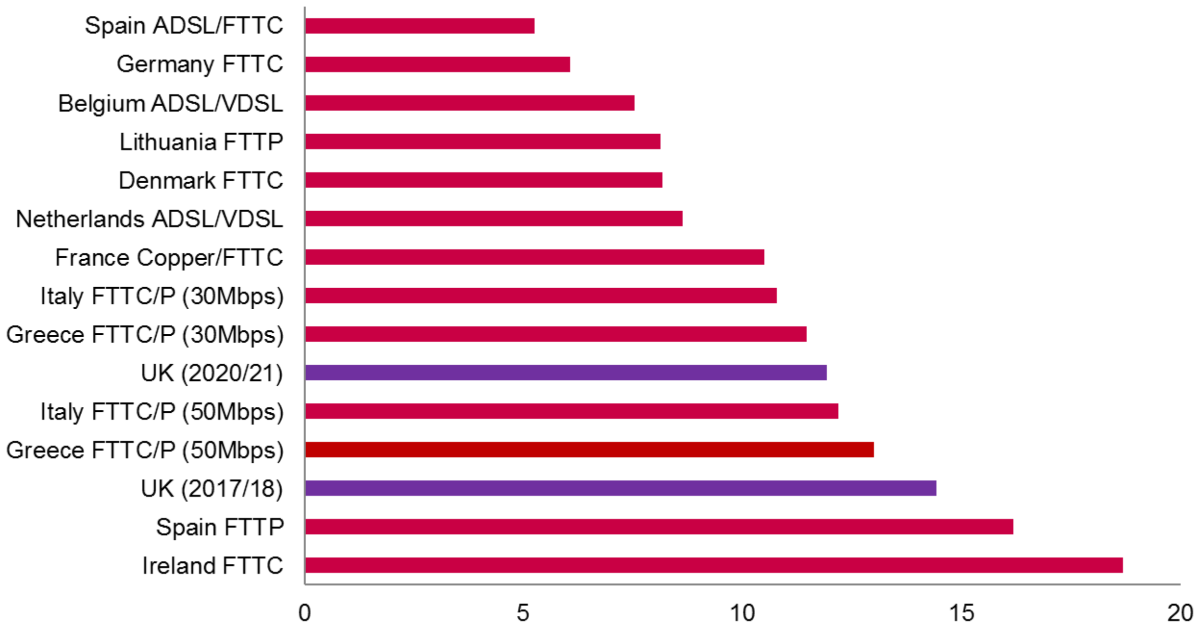
Source: Ofcom, using BT/Openreach information

Cross check: Other European NRAs' charge controls

A15.117 We have compared our unit cost estimate for GEA rentals against the charges set by other European NRAs for similar fibre-based access services. We recognise there are limitations in the use of international comparisons due to variations in the scale and nature of network deployments, costs and regulatory approaches across countries. However, we think it is useful to compare our model outputs against other NRAs' access prices as a cross check.

A15.118 Figure A15.12 below compares our unit cost estimate (including common costs) against fibre access charges in the European countries for which information was publicly available. To aid comparison, we have added our forecasted MPF rental charge to our GEA 40/10 unit cost estimate for the UK, as fibre and MPF access prices are bundled together in the majority of the countries included in our analysis.

Figure A15.12: Fibre access prices (MPF+GEA) in the UK and other European countries[414] – £ per month



Source: Ofcom based on bottom-up model for the UK and various sources[415]

[414] UK price includes MPF and GEA 40/10 rental charges. Prices in European countries were converted to £ sterling based on a five-year average exchange rate. The five-year average was calculated based on the spot exchange rate reported by the Bank of England for the period from 19 January 2013 to 19 January 2018. We note that the price for Germany is understated on account of an additional annual fee for Vectoring/MSAN services, which we do not include.
[415] Cullen International, 2017. Virtual unbundling (VULA), for European countries.
Erhvervsstyrelsen. Afgørelse om fastsættelse af maksimale netadgangspriser efter LRAIC metoden for 2018 – fastnet https://erhvervsstyrelsen.dk/gaeldende-prisafgoerelse-2018-fastnet [accessed 2 February 2018]
Agcom. Resolution no. 623/15 / CONS
https://www.agcom.it/documentazione/documento?p_p_auth=fLw7zRht&p_p_id=101_INSTANCE_2fsZcpGr12AO&p_p_lifecycle=0&p_p_col_id=column-1&p_p_col_count=1&_101_INSTANCE_2fsZcpGr12AO_struts_action=%2Fasset_publisher%2Fview_content&_101_INSTANCE_2fsZcpGr12AO_assetEntryId=3524760&_101_INSTANCE_2fsZcpGr12AO_type=document [accessed 2 February]
European Commission letter. https://circabc.europa.eu/sd/a/b890a21f-dcb8-4e5c-81bb-5348395765b7/FR-2016-1832-1833-1834%20ADOPTED_publication_EN.pdf [accessed 18 February]
Cnmc. Oferta de referencia del nuevo servicio ethernet de banda ancha
https://www.cnmc.es/sites/default/files/editor_contenidos/Telecomunicaciones/Ofertas/NEBA/2017_Texto%20NEBA%20Octubre%202017.pdf [accessed 18 February]

A15.119 The comparison does show that our forecasted MPF + GEA 40/10 rental charge is in line with fibre charges set in other European countries.

A15.120 As noted above, we have not calibrated our model outputs against the charges set by other NRAs. In addition to the comparability issues identified above, we stress the following caveats in connection with our fibre access charge comparison:

- exchange rates have observed significant volatility over the last three years, which may distort the ranking of countries;
- characteristics of the underlying access products, such as download speed and access technology (ADSL/FTTC/FTTP), vary from country to country;
- in some countries fibre prices have remained unregulated, e.g. Germany, Netherlands and Ireland, meaning that access prices in these countries may not reflect costs;
- the relevant timeframe and cost standard used to set access prices also varies across the sample.

Conclusion

A15.121 Based on the analysis of asset counts and costs set out above, we consider that the bottom-up model appears well calibrated. We have also cross-checked the results against fibre access prices in other European countries and find that the results are within a reasonable range.

Telia. VIETINĖS ŠVIESOLAIDINĖS LINIJOS SKAIDULOS PASLAUGA https://www.telia.lt/documents/20184/34951/6_priedas%28skaidulos_techniniai_duomenys%29_nauja_teo_2016.03-z5bvtynt.pdf/8beb867b-96ee-4410-8317-8e26f5611fdb [accessed 18 February]
Openeir. Bitstream price list http://www.openeir.ie/WorkArea/DownloadAsset.aspx?id=5116
Bundesnetzagentur. https://www.bundesnetzagentur.de/SharedDocs/Pressemitteilungen/DE/2017/31072017_Vectoring.html [accessed 18 February]

A16. Bottom-up and top-down models: results and sensitivities

A16.1 This annex presents the results of our top-down and bottom-up models for the forecast unit costs of MPF and GEA 40/10 rentals respectively. We also discuss the sensitivity of our models to changes in key inputs, which forms part of the quality assurance process we use to ensure the robustness of our models.

A16.2 As explained in Section 4, the top-down and bottom-up models are run using a common control module. The control module contains inputs to each of the models, allows these inputs to be varied and presents a summary of the results from the models. The sensitivities that are run in this annex can be found as pre-set scenarios in the control module.

A16.3 The bottom-up model calculates the costs of GEA services on a LRIC basis, which is inputted to the top-down model. The top-down model calculates the costs of MPF services, allocates common costs to copper and fibre services, and calculates the final X numbers for baskets of services.

A16.4 The remainder of this annex is structured as follows:

a) we first explain the impact of common cost allocation between MPF and GEA services;

b) we present the top-down model results and sensitivities; and

c) we present the bottom-up model results and sensitivities.

A16.5 We conclude that our testing of the top-down and bottom-up models shows that they behave as we intended and expected. In particular, the direction and size of the impact in the models for all the sensitivities conducted were as we would expect when the input assumptions are changed.

Impact of our common cost allocation between MPF and GEA services

A16.6 Our overall approach to allocating common costs between MPF and GEA is explained in Section 2, and the implementation of this approach is explained in Annexes 11 and 12. In summary, we have allocated common costs across MPF and fibre services using an equi-proportional mark-up (EPMU). We have decided to allocate the same common cost per line for MPF and WLR rentals when forecasting costs in the top-down model.

A16.7 This reallocation of common costs has an impact on the rental charges for both MPF[416] and GEA 40/10, which we set out in the table below. This shows that the reallocation of

[416] We note that it also has an impact on forecasted costs for WLR and SMPF, as shown in the top-down model, but that we do not set charge controls for these rental services.

common costs leads to a decrease in the cost of MPF rentals and an increase in the costs of GEA 40/10 rentals.

Table A16.1: Forecast costs in 2020/21 before and after allocation of common costs (£ per annum, nominal prices)

	Before[417]	After
MPF rental	91.94	84.03
GEA 40/10 rental	45.29	59.04

Source: Outputs from top-down and bottom-up models

A16.8 In Annex 23 we discuss our decision to set MPF migration service charges at LRIC and soft ceases at zero.[418] For all other MPF ancillary services that we set a charge control, we decided to set charges on a FAC basis, or implemented a flat cap or an alignment of charges intended to mimic a FAC-based charge control. In the table below we present our cost estimates for MPF migrations in 2020/21, before and after the allocation of common costs.

Table A16.2: Forecast MPF migration unit costs in 2020/21, before and after allocation of common costs (£ per annum, nominal prices)

	Before	After
MPF Single Migrations	25.51	24.14
MPF Bulk Migrations	18.77	17.67

Source: Outputs from top-down and bottom-up models

Top-down model results and sensitivities

A16.9 This sub-section presents the outputs of the top-down model and sensitivity analysis based on changes in key assumptions, focusing on the MPF rental service. It is structured as follows:

a) we first show the results for MPF rentals, connections, and related ancillaries;[419]

b) we then describe the assumptions used that we flex as part of the sensitivity analysis; and

c) we then analyse the sensitivity of the unit cost of MPF rentals under a range of assumptions.

[417] Note that our ‘before’ figure shows the forecast MPF rentals using a weighted average cost across SML1 and SML2, whilst the ‘after’ figure is specifically for SML1. Furthermore, the ‘before figure’ for GEA 40/10 rentals does not include any common costs that are currently allocated by BT to GEA 40/10 Rentals, whilst the ‘after’ figure will include a proportion of the common costs that BT currently allocates to GEA rentals.

[418] We note that in BT’s RFS the FAC for MPF and SMPF soft ceases is already allocated to their respective rental services.

[419] We note that for the three baskets listed below (for hard cease, co-mingling, and tie cable services), these controls will also apply to the respective SMPF ancillaries.

Model results

A16.10 Our annual unit cost estimates for MPF rentals, and one-off cost estimates for MPF connections and ancillary services are presented in Table A16.3 below. For most of these services, the unit cost estimates are below Openreach's current access prices and thus our charge controls will result in lower regulated prices. Note that the adjusted glidepath explained in Section 3 means that access prices need to align with costs by 2019/20, so the charge controls in 2020/21 are reflective of changes in the underlying unit cost estimates.

Table A16.3: MPF service results

Service	Current annual price (£)	Nominal annual unit cost (£)		Charge controls		
		2019/20	2020/21	2018/19	2019/20	2020/21
MPF SML1 Rental	84.38	84.09	84.03	CPI-1.6%	CPI-2.7%	CPI-2.1%
MPF New Provides Basket	Various			CPI-14.1%	CPI-8.7%	CPI-3.0%
MPF Single Migration	30.26	24.38	24.14	CPI-15.1%	CPI-9.2%	CPI-3.0%
MPF Bulk Migration	20.97	17.83	17.67	CPI-12.0%	CPI-7.5%	CPI-2.9%
Hard Ceases Basket		Various		CPI-21.1%	CPI-12.5%	CPI-4.3%
Co-Mingling New Provides and Rentals services basket[420]		Various		CPI+30.4%	CPI+12.6%	CPI-4.8%
LLU Tie Cables basket		Various		CPI-1.0%	CPI-1.9%	CPI-3.4%

Source: Outputs from the control module.

A16.11 Compared to the current MPF rental charge of £84.38 per annum (which is £7.03 per month), the forecast unit cost in 2020/21 is £84.03 per annum (which is £7.00 per month).

[420] We note that the relatively large positive increase in charges for this basket in 2018/19 (and to a lesser extent in 2019/20) is due a misalignment of revenues and costs in 2016/17, i.e. costs are above revenue in 2016/17.

Sensitivity analysis

A16.12 We have conducted a sensitivity analysis on the key assumptions used when forecasting costs for MPF rental services. The purpose of this analysis is to test how the model behaves when its input parameters are flexed, and all results are presented following our allocation of common costs.

Values changed as part of the sensitivity analysis

A16.13 We have identified and varied the key parameters set out below. When setting input values for the analysis, we have sought to use values that are sufficiently different to test the top-down model, but not so different that we believe they would fall outside what could be a reasonable range for each parameter.

A16.14 In some cases, we have departed from the range of values used in our March consultation. The purpose of this current exercise is to illustrate the impacts of varying inputs on the model results, and not to create a range of reasonable values on which to consult.

a) **Volumes:** the key service volume assumptions that impact MPF rentals are our forecasts of Openreach lines and broadband penetration (as set out in Annex 10). We use a low volume sensitivity which assumes a greater decrease in the number of Openreach lines due to the impact from competitive networks (i.e. non-BT networks), and dampened household and business site growth; [421] and a high volume forecast in which we assume the opposite.

b) **WACC:** we have decided on a nominal pre-tax WACC of 7.9% in 2019/20 and 2020/21 (see Annex 20 for further details), and use low and high sensitivities of ± one percentage point around this, so 6.9% and 8.9% respectively.

c) **Non-repair efficiency:** we have decided on an opex efficiency (excluding repair cost related efficiencies) of 4.5% and capex efficiency of 3% (see Annex 19), and use low and high sensitivities of ± one percentage point around this, so 5.5% and 3.5% respectively for opex, and 4% and 2% respectively for capex.

d) **Input operating cost trends:** we have estimated the price trends for the cost inputs that BT uses, notably pay and non-pay inflation rates for each year which average to around 2.8% and 3.5%, respectively, over the forecast period (i.e. 2017/18 to 2020/21) (see Annex 17). We use low and high sensitivities of ± one percentage point around this, so 1.8% and 3.8% respectively for pay, and 2.5% and 5.5% respectively for non-pay.

[421] For households, we assume a 0.5 percentage point reduction in growth (relative to our final decision). For business site growth, we apply a dampening factor of 1.6 (rather than 1.4) and consider forecast GDP which further dampens our forecast business site growth. This is combined with using a dampening factor of 1 when forecasting Openreach business lines per site (rather than 1.1). For the competitive network impact, we assume a 20% higher impact over the charge control period.

e) **Cumulo:** we have estimated cumulo costs as explained in Annex 21. The high sensitivity increases BT's UK Rateable Values by 5% and the low sensitivity decreases them by 5%, which primarily impacts the attribution of cumulo costs to MPF services.

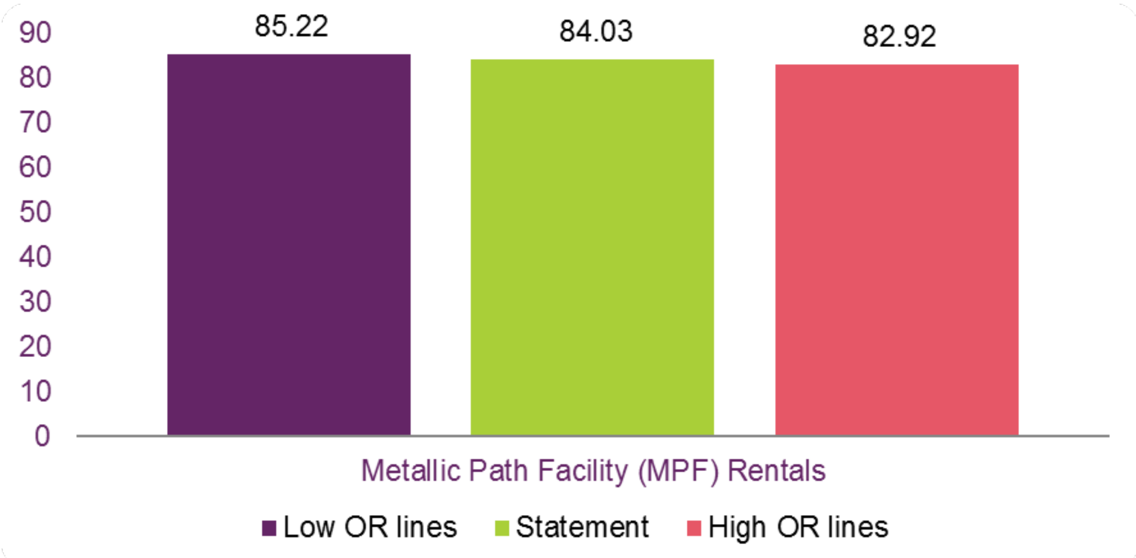
f) **Pensions:** we have added [✂] costs to our modelling to account for our estimate of BT's higher pension service costs as explained in Annex 12. We have applied a +/- 1m sensitivity to this assumption to test its impact on MPF rentals.

A16.15 The results of these sensitivities are summarised in the sub-sections below, with graphs showing the forecast 2020/21 nominal annual unit cost for MPF rental services in the middle, the low case to the left and the high case to the right. In all cases the model behaves as we would expect when the input assumptions are changed, both in terms of the direction and the size of the change in model output.

Volume sensitivity

A16.16 We find that the forecast charge for MPF rentals reacts as expected in our high and low volume forecast scenarios: a greater number of forecast Openreach lines results in a lower forecast unit cost for MPF rentals and *vice versa*. The results of this sensitivity analysis are shown below.

Figure A16.4: Volumes sensitivity on MPF rentals in 2020/21 (£, nominal prices)

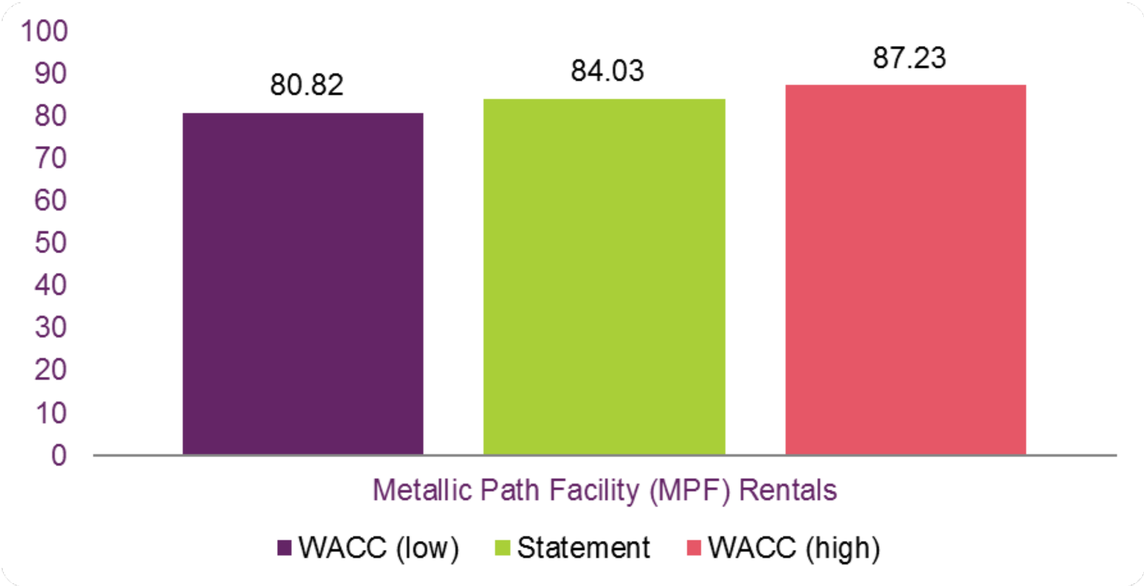


Source: Outputs from the control module

WACC sensitivity

A16.17 We find that the forecast charge for MPF rentals is relatively sensitive to changes in the WACC, as we would expect. The return on capital employed is determined by the WACC multiplied by the mean capital employed (MCE). This means that when MCE is high, a one percentage point change in WACC can result in a large amount of additional capital costs and thus a higher FAC. As expected, a higher WACC results in a higher forecast unit cost for MPF rentals. The results of this sensitivity analysis are shown below.

Figure A16.5: WACC sensitivity on MPF rentals in 2020/21 (£, nominal prices)

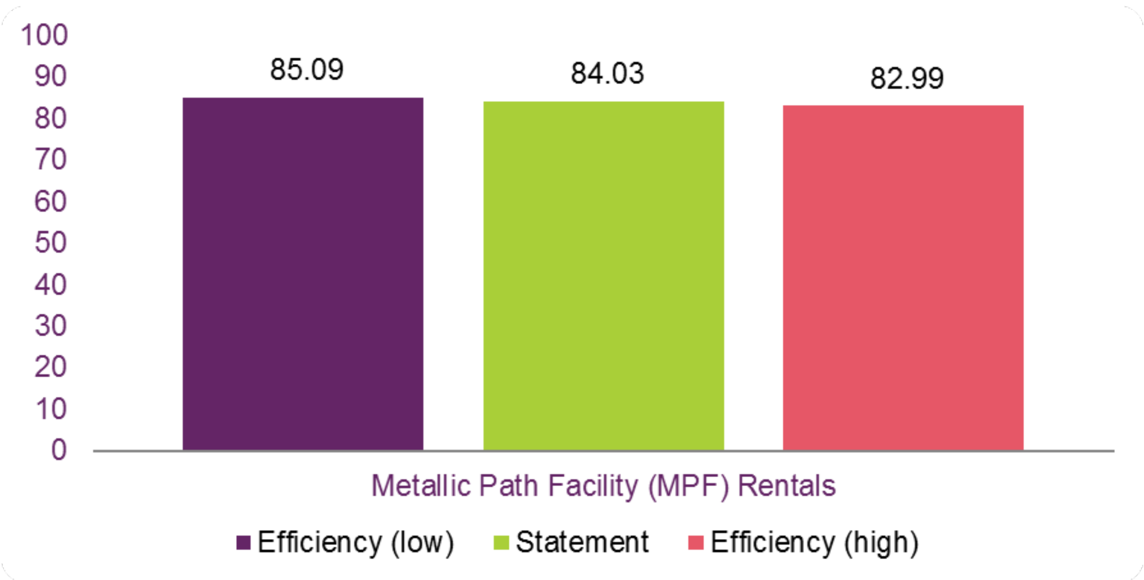


Source: Outputs from the control module

Non-repair efficiency sensitivity

A16.18 As expected, a higher efficiency rate (excluding repair cost related efficiencies) results in lower forecast unit cost for MPF rentals, and *vice versa*, but the impact of a one percentage point difference is relative limited. The results of this sensitivity analysis are shown below.

Figure A16.6: Non-repair efficiency sensitivity on MPF rentals in 2020/21 (£, nominal prices)

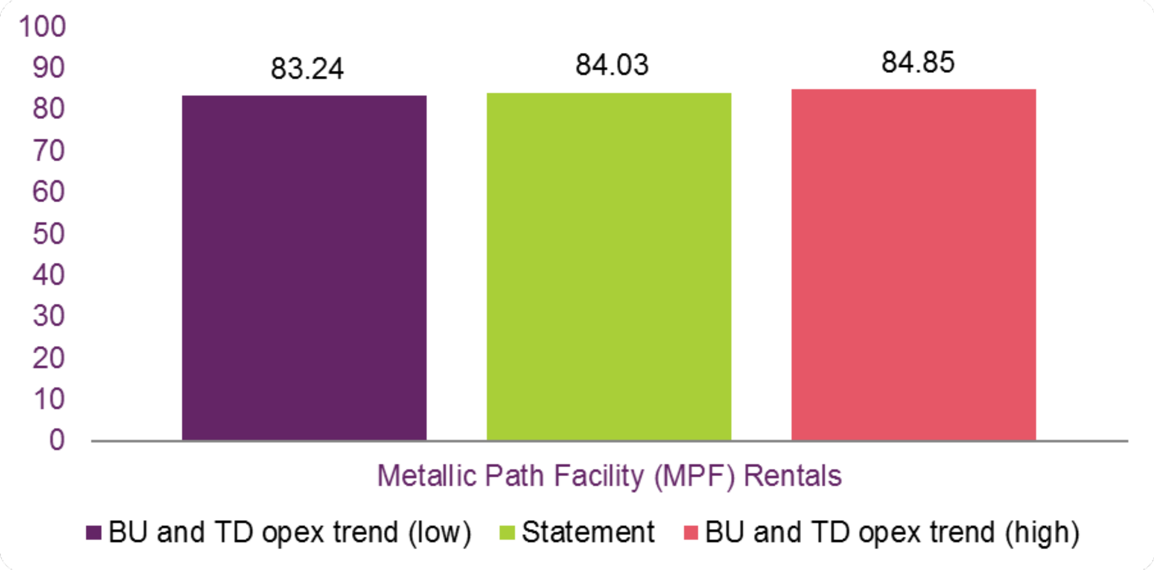


Source: Outputs from the control module

Input operating cost trend sensitivity

A16.19 We also find that there is a limited impact on the unit cost for MPF rentals when assuming the high and low scenario for the operating cost trends. As expected, a higher cost trend results in a higher forecast unit cost, and *vice versa*. The results of this sensitivity analysis are shown below.

Figure A16.7: Input operating cost trend sensitivity on MPF rentals in 2020/21 (£, nominal prices)



Source: Outputs from the control module

Cumulo sensitivity

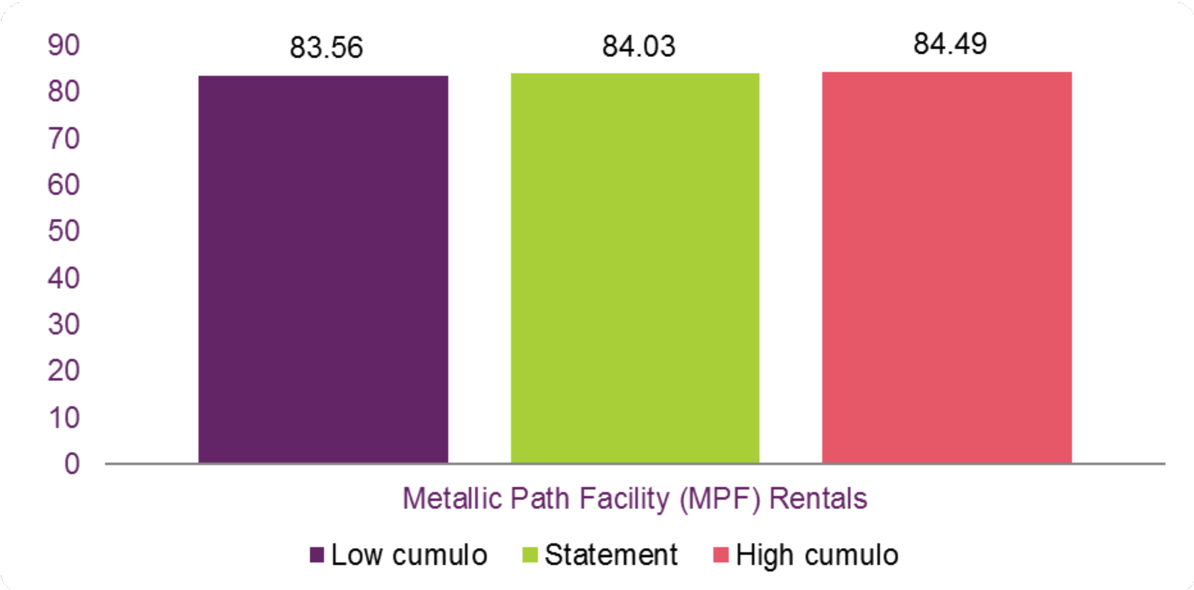
A16.20 For the low sensitivity we reduce BT's 2017/18 RVs by 5%. This has the effect of reducing BT's 2020/21 total cumulo liability and decreasing the 2020/21 cumulo unit cost for MPF services £5.91 by 7%. NGA unit cumulo costs remain unchanged in 2020/21 due to the way we have decided to attribute cumulo costs to GEA services.[422]

A16.21 For the high sensitivity we increase our forecasts of BT's 2017/18 RV by 5%. This has the effect of increasing BT's 2020/21 total cumulo liability and increasing the 2020/21 cumulo unit cost for MPF services by 7%. Again, NGA unit cumulo costs are unchanged in 2020/21.

A16.22 We note that any impact from cumulo has an added impact of changing the amount of common cost per line.[423] For example, a lower unit cumulo cost for MPF rentals results in a lower common cost per line due to the EPMU approach.[424] The results of this sensitivity are shown in the figure below.

[422] We provide our decision on the attribution of cumulo costs in Annex 21. This also provides more details on Rateable Values (RVs), which are measures that the rating authorities use to assess non-domestic rates.
[423] This is due to our decision to allocate fixed and common costs using an equi-proportional mark-up approach (as set out in Annex 11). This approach allocates common costs based on the relative long run incremental costs (LRICs) of copper and fibre services. We model cumulo as part of the service LRICs.
[424] Cumulo falls within the GEA and MPF LRICs, and the increase in cumulo results in a greater proportional change to the GEA LRIC than MPF which leads to GEA picking up a greater proportion of common costs.

Figure A16.8: Cumulo sensitivity on MPF rentals in 2020/21 (£, nominal prices)

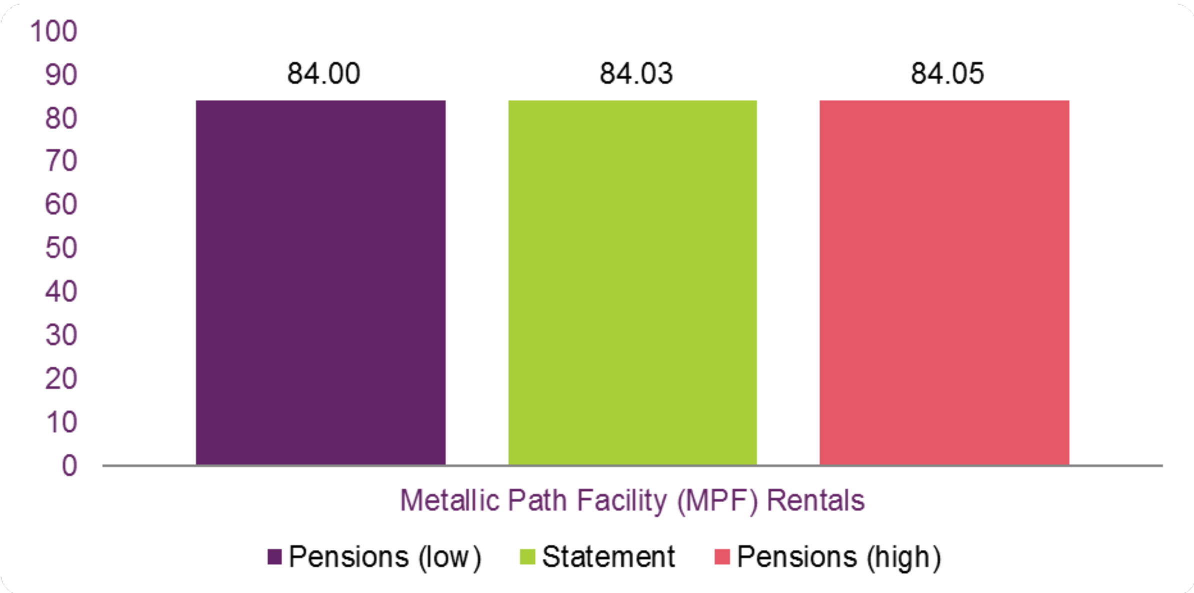


Source: Outputs from the control module

Pensions adjustment

A16.23 As expected, a higher pension service charge adjustment results in a higher MPF rentals, and *vice versa*. The MPF rental, however, appears insensitive to this adjustment, remaining mostly flat when the assumption is changed. The results of this sensitivity are shown in the figure below.

Figure A16.9 Pensions sensitivity on MPF rentals in 2020/21 (£, nominal prices)



Source: Outputs from the control module

Bottom-up model results and sensitivities

A16.24 This sub-section presents the results of the bottom-up model and accompanying sensitivity analysis. Mirroring the analysis carried out above for the top-down model, we first show the model outputs, then describe the key assumptions flexed in order to test the sensitivity of the model and present the results of our sensitivity analysis. All model outputs and sensitivities are presented after the allocation of common costs.

Model results

A16.25 Our unit cost estimates for the modelled GEA services are presented in Table A16.10 below. These estimates are below Openreach's current access prices, implying CPI-X controls. Note that the adjusted glidepath means that access prices need to align to costs by 2019/20, so positive 'X' values in 2020/21 for GEA connection and ancillary services are reflective of year on year changes in our unit cost estimates.

Table A16.10: Bottom-up model results

Services	Current level of charges, £ per annum	Unit cost (£ per annum, nominal)		Charge control 'X'		
		2019/20	2020/21	2018/19	2019/20	2020/21
GEA 40/10 Rental	88.80	59.98	59.04	CPI-24.8%	CPI-14.5%	CPI-3.6%
GEA Connection	49.00	45.01	46.13	CPI-7.2%	CPI-5.1%	CPI+0.5%
GEA Start of Stopped Line	11.00	2.92	3.00	CPI-60.6%	CPI-38.0%	CPI+0.8%
GEA CP to CP Migration	11.00	2.92	3.00	CPI-60.6%	CPI-38.0%	CPI+0.8%
GEA 40/10 Bandwidth changes	11.25	5.70	5.51	CPI-38.2%	CPI-22.5%	CPI-5.5%

Source: Outputs from the control module

A16.26 Compared to the current GEA 40/10 rental charge of £88.80 per annum (which is £7.40 per month), the forecast unit cost in 2020/21 is £59.04 per annum (which is £4.92 per month).

Sensitivity analysis

A16.27 We have performed a sensitivity analysis on our GEA 40/10 rental cost estimate by flexing several key model assumptions in relation to:

a) demand inputs: total Openreach lines, copper and fibre broadband take-up and the competitive network impact (as described in Annex 10);

b) network inputs: new cabinets, cabinet type split, bandwidth demand, asset lives and cabinet power consumption (as described in Annex 14); and

c) cost inputs: WACC, cumulo, network element unit costs and cost trends and vectoring uplift (as described in Annexes 20, 21, and 29).

A16.28 The details of the sensitivities we have tested are summarised in the table below.

Table A16.11: Bottom-up model sensitivities

Assumption		Low	Statement	High
Demand inputs	Total OR lines	See paragraph A16.14a above.		
	BB take-up growth[425]	Copper: 1% Fibre: 6%	Copper: 1.5% Fibre: 7%	Copper: 2% Fibre: 8%
	Altnet impact	-20%	See Annex 10	+20%
Network inputs	Proportion of small cabinets	[✂] (~19%)	[✂] (~34%)	40%
	Bandwidth demand	-20%	Statement decision (see Network module)	+20%
	Asset lives	DSLAM [✂] (~7.1)	DSLAM [✂] (~9.1) yrs	DSLAM [✂] (~11.1) yrs
	Power consumption (KW) per line	-20%	[✂] (~21)	+20%
	Cabinet expansion (18/19 – 20/21)	c.2,000	c.5,000	c.8,000
Cost inputs	WACC	2019/20: 8.0% 2020/21: 7.9%	2019/20: 9.0% 2020/21: 8.9%	2019/20: 10.0% 2020/21: 9.9%
	Cumulo	Rateable value of £12 per GEA customer as the attribution basis and as the basis for GEA Material Changes in Circumstance (MCCs) (See Annex 21)	Rateable value of £18 per GEA customer as the attribution basis and as the basis for GEA MCCs	Rateable value of £27 per GEA customer as the attribution basis and as the basis for GEA MCCs
	Unit capex Unit opex Capex cost trend Opex cost trend	-20%	Statement decision (see Network module)	+20%
	Vectoring uplift	10%	15%	20%

Source: Ofcom analysis

425 Other parameters are also flexed in this sensitivity (i.e. penetration growth dampening factors) but only affect post 2020/21 results.

A16.29 We show the results for each of these sensitivities in a series of graphs below and discuss each in turn. In each case, we present our decision on the 2020/21 nominal unit cost for GEA rentals in the middle, and the low case to the left and the high case to the right of it.

Demand inputs

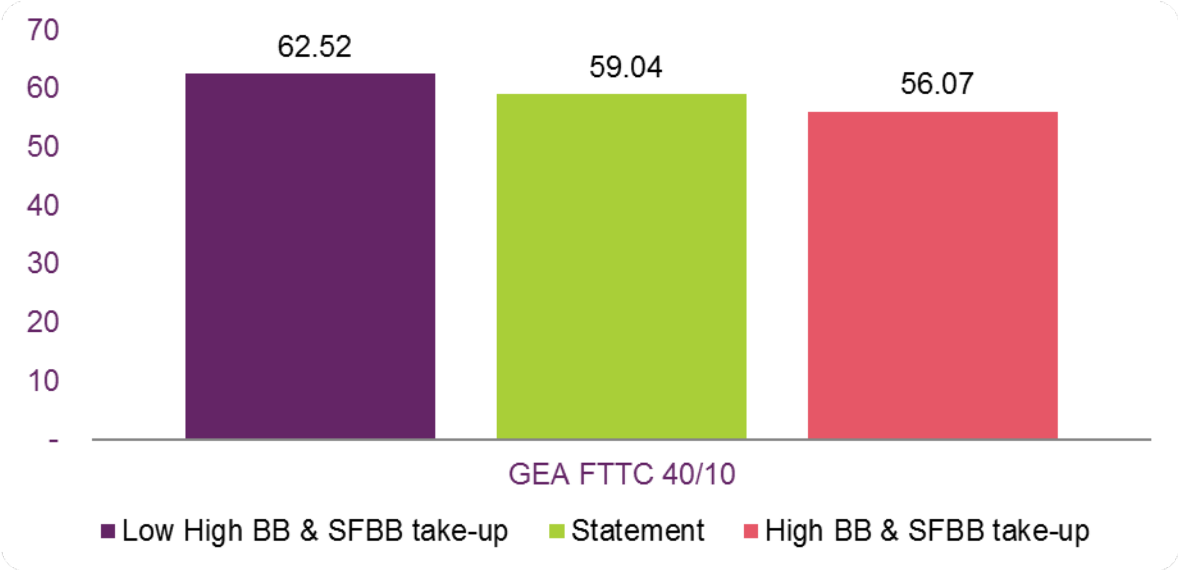
A16.30 As shown in Table A16.11 our demand sensitivity analysis has three elements to it. The results of the first of these, the total Openreach lines (as described above) are shown below. A lower number of GEA lines results in a higher GEA unit cost and *vice versa*, as we would expect.

Figure A16.12: Openreach lines sensitivity on GEA rentals in 2020/21 (£, nominal prices)

Source: Outputs from the control module

A16.31 The effect of the second element of our demand sensitivity, annual growth in the broadband take-up of copper and fibre services is shown in Figure A16.13 below. In the low case, we assume 1% copper growth and 6% fibre growth, and in the high case 2% and 8% growth respectively. These compare to our decision of 1.5% copper growth and 7% fibre growth. Lower copper and fibre growth results in a higher GEA unit cost and *vice versa*, as we would expect.

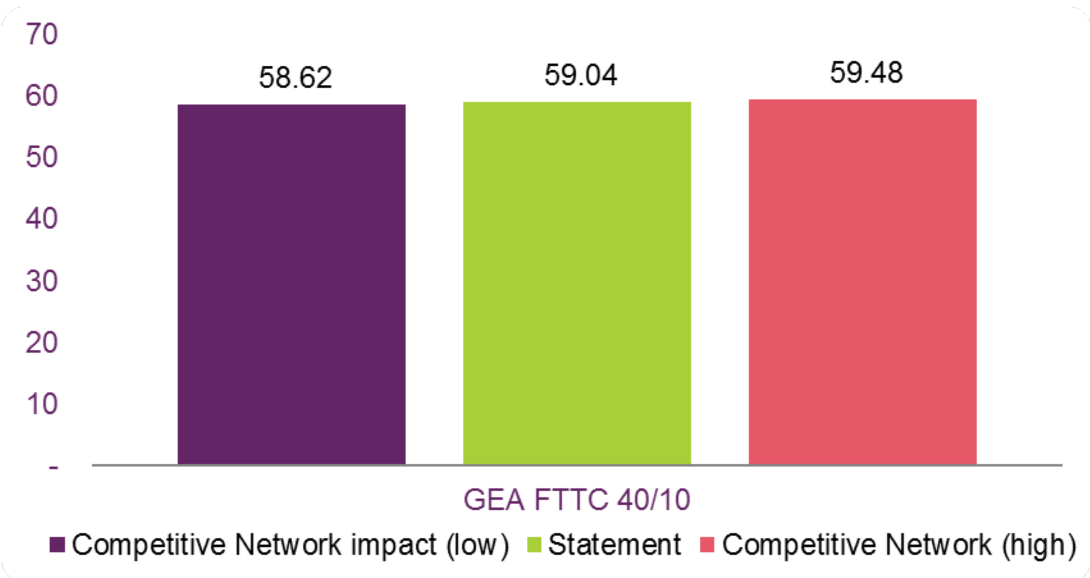
Figure A16.13: Copper and fibre broadband take-up sensitivity on GEA rentals in 2020/21 (£, nominal prices)



Source: Outputs from the control module

A16.32 The effect of the third element of our demand sensitivity, the competitive network impact is shown below. In the low case, we assume 20% lower impact and in the high case 20% higher impact, compared to our decision set out in Annex 10. As expected, the GEA unit cost is lower in the low competitive network impact, and *vice versa*. The lower competitive network impact implies a greater number of GEA lines for the modelled network, which in turn implies a lower unit cost.

Figure A16.14: Competitive network impact sensitivity on GEA rentals in 2020/21 (£, nominal prices)



Source: Outputs from the control module

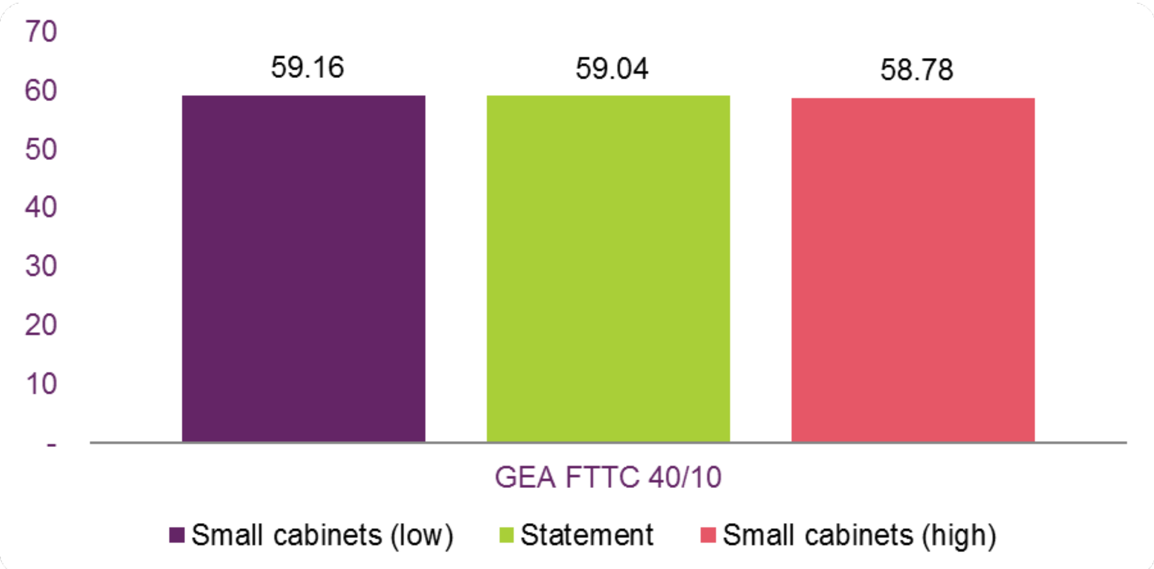
Network inputs

A16.33 As summarised in Table A16.11 we have tested the sensitivity of the bottom-up model to network inputs in five ways. We find that the forecast GEA rental charge is not very sensitive to any of the network inputs examined.

A16.34 Figure A16.15 below shows the sensitivity of the results to the proportion of small cabinets assumed. In the low case, we assume that [✂] (~19%) of FTTC cabinets are small (Type 1 cabinets) and in the high case 40%, compared to our decision of [✂] (~34%). Our results are relatively insensitive to these scenarios, with the low case producing slightly higher unit costs and *vice versa* in the high case.

A16.35 The above results can be explained by the fact that smaller cabinets are less expensive to build; so the greater the share of these cabinet types, the lower the unit cost would be. This effect is somewhat offset by the fact that a second cabinet is more likely to be required if a small (rather than a large) cabinet is installed in the first place. However, this effect does not seem to be big enough to offset the input price effect (described above) in our low and high case scenarios.

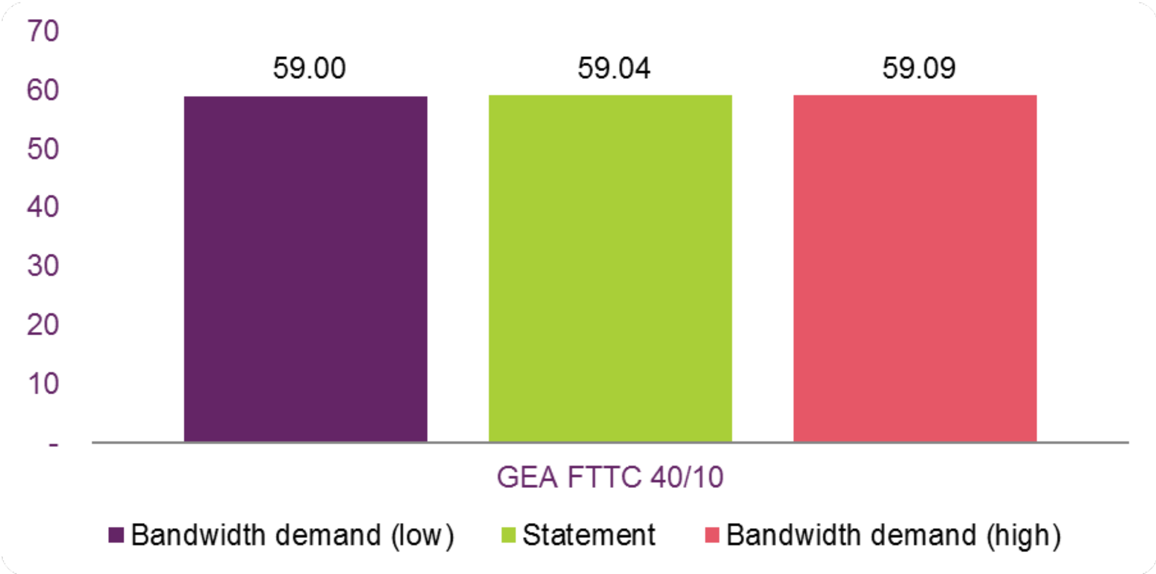
Figure A16.15: Proportion of small cabinets sensitivity on GEA rentals in 2020/21 (£, nominal prices)



Source: Outputs from the control module

A16.36 Our results are also relatively insensitive to bandwidth demand, as shown in Figure A16.16 below. In the low case we assume bandwidth demand growth is 20% below, and in the high case 20% above, than decision outlined in Annex 29. The low case produces a very slightly lower unit cost result, and *vice versa* in the high case. Higher bandwidth demand growth may require additional fibre links from the cabinet to the Exchange, as well as additional port capacity at the Exchange. This result suggests that the marginal cost of supplying higher speeds in the modelled network is low.

Figure A16.16: Bandwidth demand sensitivity on GEA rentals in 2020/21 (£, nominal prices)

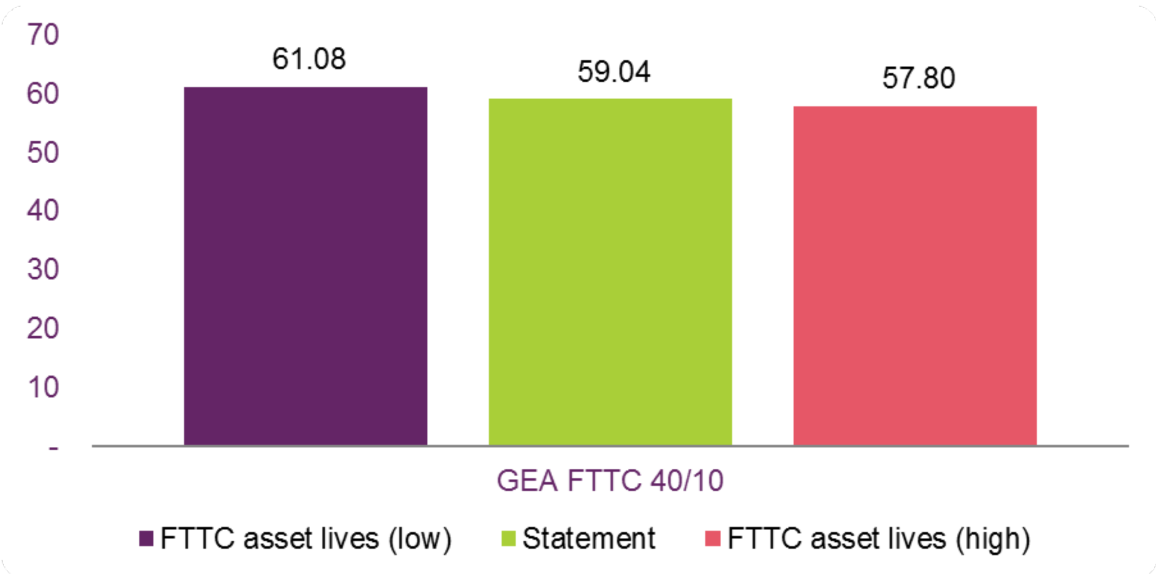


Source: Outputs from the control module

A16.37 Figure A16.17 shows sensitivity to our DSLAM asset life assumption, and indicates that while the impact is greater than in the sensitivities described above, the unit cost remains relatively flat across the different scenarios tested. In the low case, we assume a DSLAM asset life of [✂] (~7.1) years and in the high case [✂] (~11.1) years, compared to our decision of [✂] (~9.1) years.

A16.38 The low case produces somewhat higher unit costs and *vice versa* in the high case. This is because the longer the asset life assumed, the lower the depreciation charge.

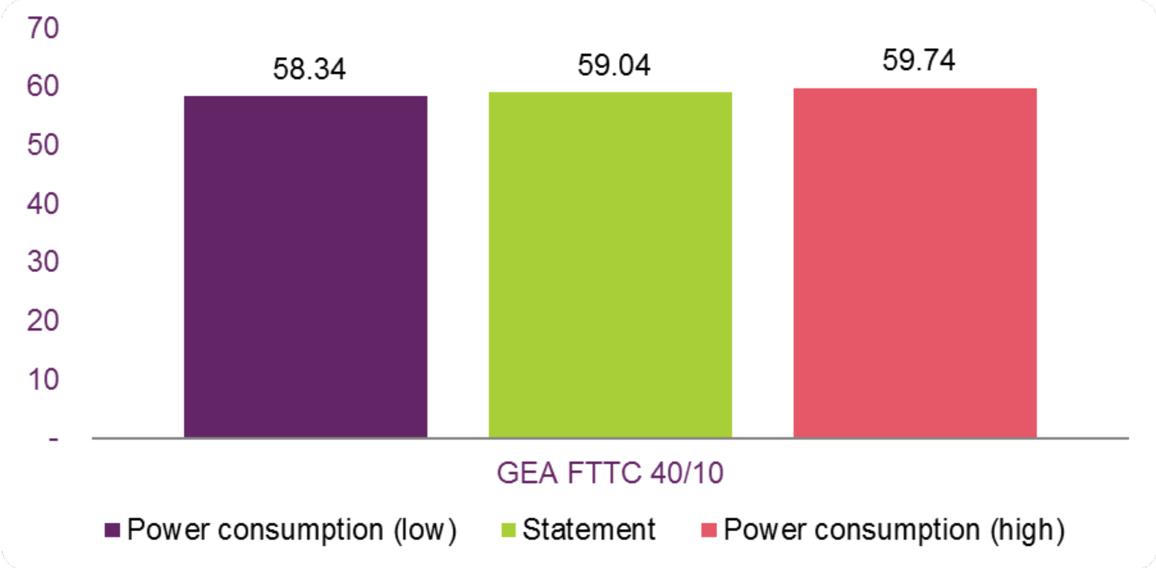
Figure A16.17: Asset lives sensitivity on GEA rentals in 2020/21 (£, nominal prices)



Source: Outputs from the control module

A16.39 Figure A16.18 shows the sensitivity of the results to changes in our DSLAM power consumption assumption per line. In the low case, we assume each line drives 18 kW more of electricity consumption per year and in the high case 27 kW, compared to our decision of [✂] (~21) kW. As we would expect, lower power consumption results in a lower unit cost, and *vice versa*, but the results are relatively insensitive.

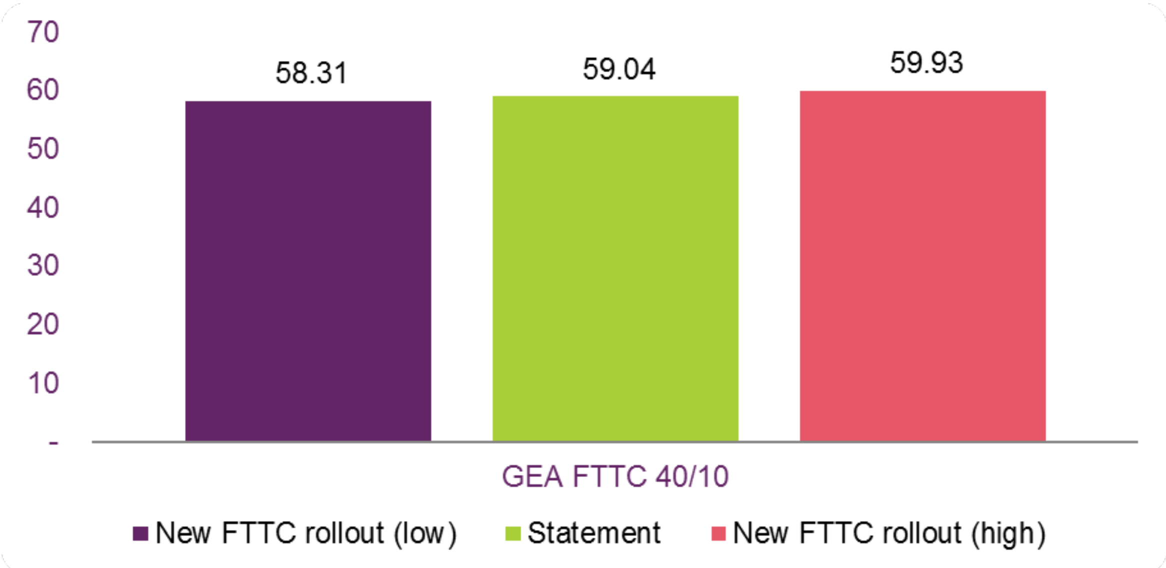
Figure A16.18: DSLAM power consumption sensitivity on GEA rentals in 2020/21 (£, nominal prices)



Source: Outputs from the control module

A16.40 Figure A16.19 shows the sensitivity of the results to changes to the assumed future cabinet rollout. In Annex 14 we explained that we have added [✂] cabinets to account for Openreach's Fibre First programme. We have applied a +/- 3,000 sensitivity around this assumption. As we would expect, a lower number of additional cabinets results in a lower unit cost, and *vice versa*, but the results are again relatively insensitive.

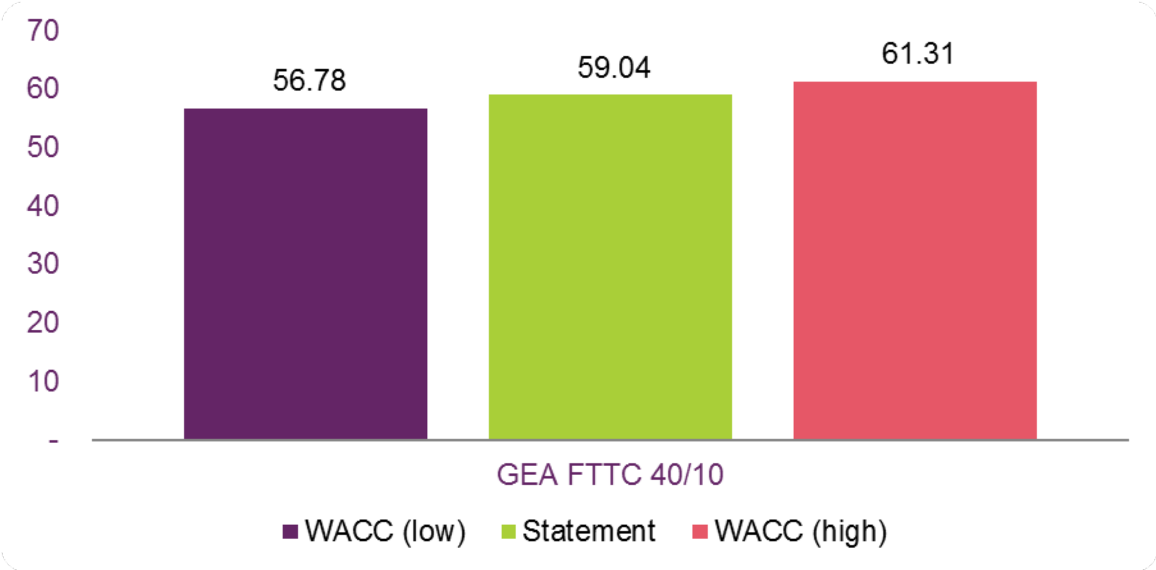
Figure A16.19 Cabinet expansion sensitivity on GEA rentals in 2020/21 (£, nominal prices)



Cost inputs

A16.41 Turning to cost inputs we find that there is a moderate impact on the forecast GEA rental charge when varying the WACC, as shown in Figure A16.20 below. In the low case, we assume a (pre-tax nominal) WACC of 8% and 7.9% for 2019/20 and 2020/21 respectively, and in the high case 10% and 9.9% for the same years. These compare to our decision of 9% and 8.9% for 2019/20 and 2020/21 respectively. As we would expect, a lower WACC results in a lower unit cost for GEA rentals and *vice versa*.

Figure A16.20: WACC sensitivity on GEA rentals in 2020/21 (£, nominal prices)

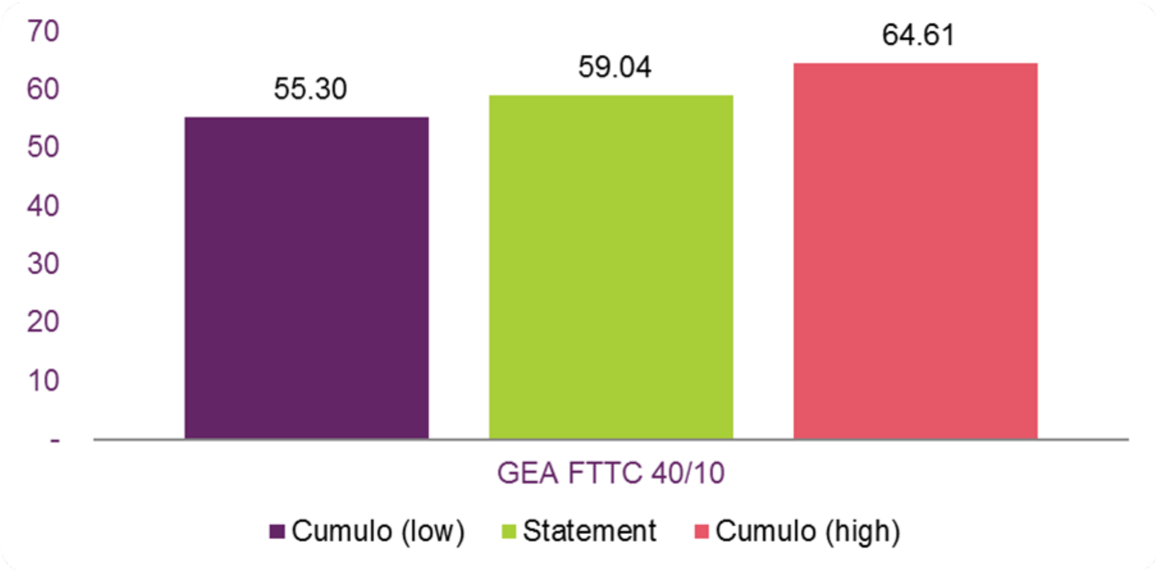


Source: Outputs from the control module

A16.42 Our sensitivity results in relation to cumulo are shown in Figure A16.21 below. We find that the low cumulo assumption (a £12 RV for every GEA customer connected compared to our decision of £18 RV) results in a lower GEA service unit cost, and *vice versa* for the high assumption (£27 RV). The direct effects of the change in cumulo are amplified by the impact that this also has on common cost allocations due to our EPMU approach.[426] There are some further implications of this sensitivity analysis on MPF unit costs. Under the attribution approach described in Annex 21 when higher amounts are attributed to GEA services then less of BT's cumulo costs are attributed to other services and vice versa. For example, the impact of the higher GEA cumulo sensitivity assumption is to reduce the MPF cumulo unit cost in 2020/21 from £5.91 in 2016/17 to £4.99.

[426] Cumulo falls within the GEA and MPF LRICs, and the increase in cumulo results in a greater proportional change to the GEA LRIC than MPF which leads to GEA picking up a greater proportion of common costs.

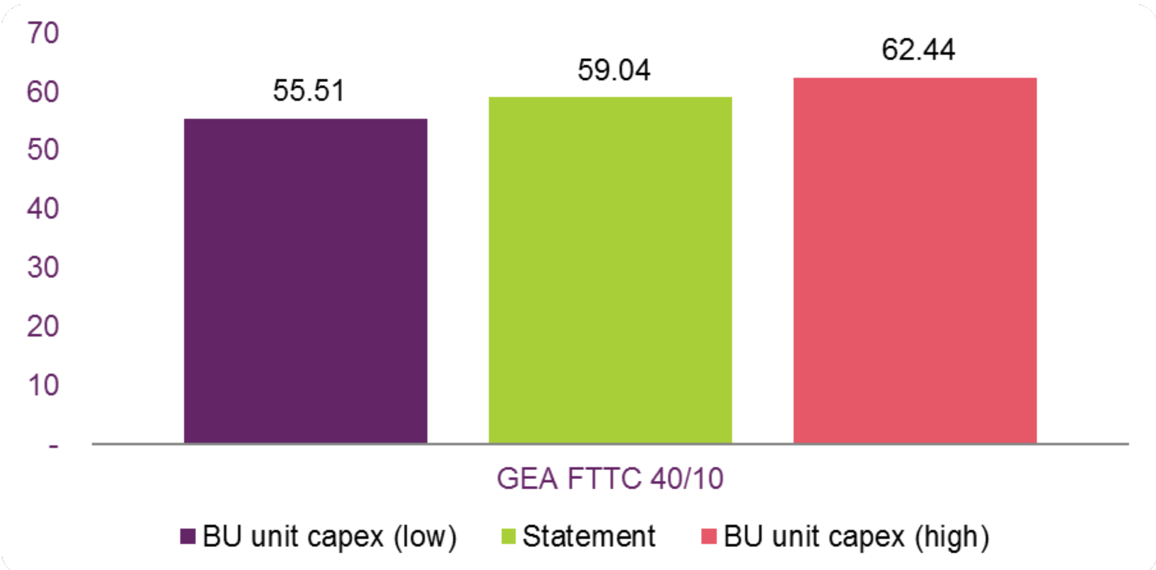
Figure A16.21: Cumulo sensitivity on GEA rentals in 2020/21 (£, nominal prices)



Source: Outputs from the control module

A16.43 Figure A16.22 below shows the sensitivity of our GEA rental forecast to changes in the unit capex assumptions. In the low case, we assume unit capex is 20% lower than our decision, and 20% higher in the high case. As we would expect, a lower unit capex leads to a lower GEA unit cost and *vice versa*.

Figure A16.22: Element unit capex sensitivity on GEA rentals in 2020/21 (£, nominal prices)

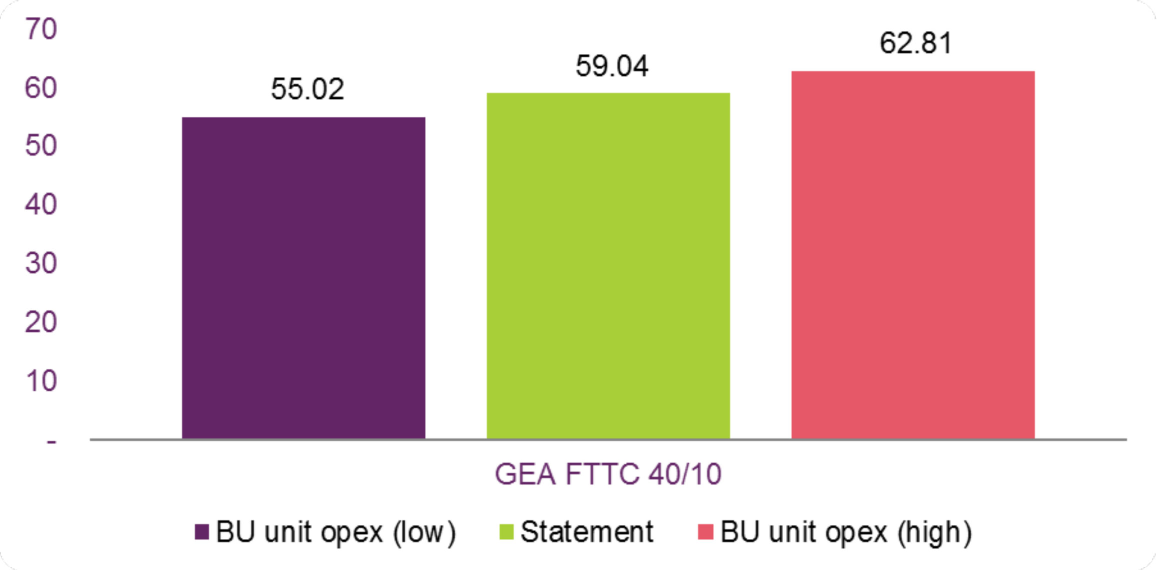


Source: Outputs from the control module

A16.44 Figure A16.23 below shows the corresponding sensitivity for changes in the unit opex assumptions. In the low case, we assume unit opex is 20% lower than our decision, and 20% higher in the high case. As we would expect, a lower unit opex leads to a lower GEA unit cost and *vice versa*.

A16.45 We note that the impact from the opex sensitivity is larger than the impact from the capex sensitivity. This is likely due to the higher importance opex has in the service cost stack (relative to capex).[427]

Figure A16.23: Element unit opex sensitivity on GEA rentals in 2020/21 (£, nominal prices)



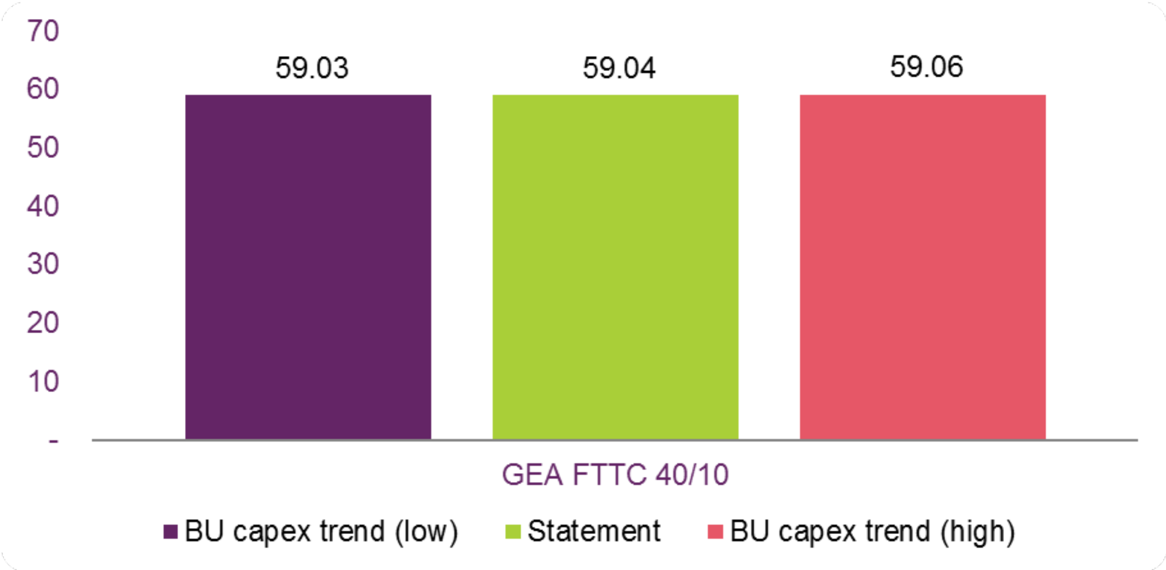
Source: Outputs from the control module

A16.46 We have tested the sensitivity of the bottom-up model to changes in our cost trend assumptions. Figure A16.24 below shows the sensitivity to capex trends, with the low scenario assuming figures 20% below our decisions, and the high scenario assuming figures 20% above.

A16.47 The low capex trend assumption results in a higher GEA unit cost, and *vice versa,* albeit the impact is modest. This seemingly counterintuitive result can be explained by consideration of the two opposing effects at play. Faster unit capex growth translates into higher element unit costs, making it more expensive for the network operator to replace/deploy network assets in future. However, growing unit capex represents a holding gain (negative cost) on existing network assets. This effect is likely to dominate in a mature network where service volumes are relatively stable over time, which we would expect to observe in the modelled network towards the end of the charge control period.

[427] Our cost modelling suggests that by 2020/21 operating costs will account for more than 50% of the total GEA rental cost stack.

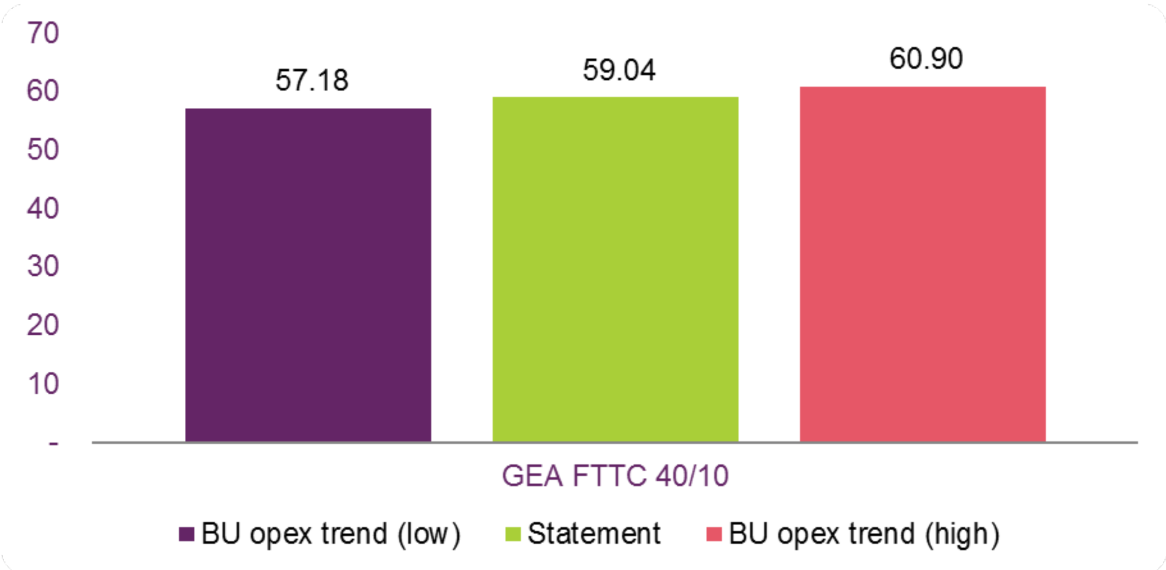
Figure A16.24: Element capex trend sensitivity on GEA rentals in 2020/21 (£, nominal prices)



Source: Outputs from the control module

A16.48 Figure A16.25 below shows the sensitivity to opex trends, with the low case assuming figures 20% below our decisions, and the high case assuming figures 20% above. The impact of this sensitivity is modest, but the low opex trend assumption produces slightly lower unit costs and *vice versa*, as we would expect.

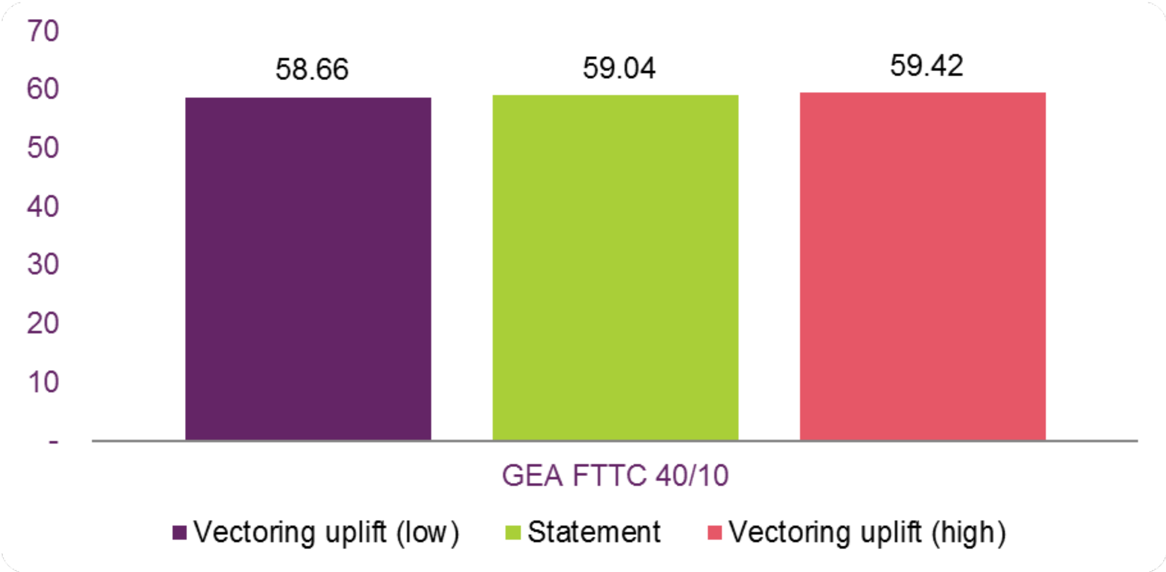
Figure A16.25: Element opex trend sensitivity on GEA rentals in 2020/21 (£, nominal prices)



Source: Outputs from the control module

A16.49 Figure A16.26 below shows the sensitivity to our vectoring uplift assumption. In the low case we assume a 10% uplift and in the high a 20% uplift, compared to our decision of 15%. The impact of this sensitivity is modest, but the low uplift produces slightly lower unit costs and *vice versa*, as we would expect.

Figure A16.26 Vectoring uplift sensitivity on GEA rentals in 2020/21 (£, nominal prices)



Source: Outputs from the control module

Combined sensitivities

A16.50 To further stress test our cost modelling we performed a sensitivity that flexes multiple assumptions at the same time. This allows us to examine whether the model still behaves as expected under extreme assumptions and when multiple interrelated parameters are changed. The table below shows the sensitivities which we have combined in this test.

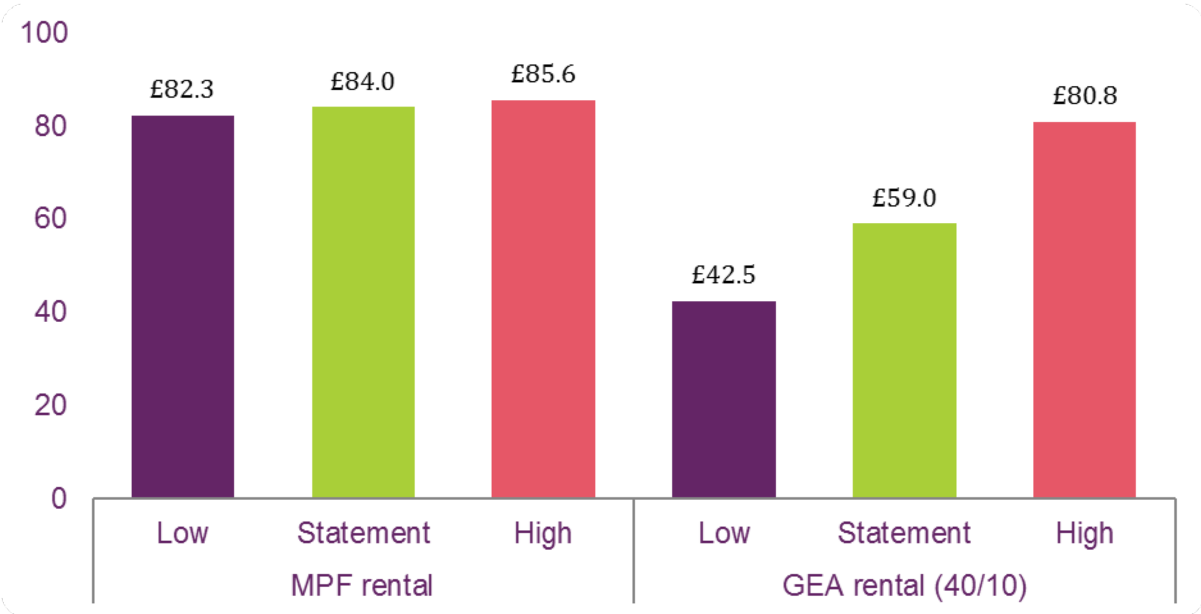
Table A16.27 Summary of assumptions in the combined sensitivity

	Low unit cost	High unit cost
Volumes	High	Low
Competitive network impact	Low	High
WACC	Low	High
Efficiency	High	Low
Opex trend	Low	High
Capex trend	Low	High
Cumulo	Low	High
Pensions adjustment	Low	High

	Low unit cost	High unit cost
DSLAM asset life	High	Low
DSLAM power consumption	Low	High
GEA unit capex	Low	High
GEA unit opex	Low	High
Vectoring uplift	Low	High

A16.51 Figure A16.28 presents the results of this test. It shows that in the combined low case, the MPF and GEA rentals are lower, and *vice versa*, as expected. The impact on the GEA rental is bigger than on MPF for two reasons. First, the MPF LRIC is less sensitive than the GEA LRIC to the set of assumptions changed. This in turn leads to a reallocation of common costs between copper and fibre services, which results in the variation in the GEA LRIC+ to be amplified, while in the MPF LRIC+ to be muted.

Figure A16.28 Combined sensitivities on MPF and GEA rentals in 2020/21 (£, nominal prices)



Source: Outputs from the control module

A16.52 Based on the sensitivity analysis above, we consider that the top-down and bottom-up models behave as intended. In particular, the direction and size of the impact in the model for all the sensitivities conducted were as we would expect when the inputs assumptions are changed.