Second addendum to 'Estimating the cost of a broadband Universal Service Obligation'

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1 Introduction

In July 2016, Ofcom commissioned Analysys Mason to undertake a cost calculation to estimate the cost of a potential broadband universal service obligation (USO). This study (the "original modelling") was based on estimates of premises on a postcode-by-postcode basis that may be eligible for such a USO: these estimates were provided by Ofcom. Our original modelling was documented in the main part of our report *Estimating the cost of a broadband Universal Service Obligation*, reference 2007855-481 (the 'Analysys Mason report') and considered four main scenarios (Scenario 1, Scenario 2, Scenario 3 and a Superfast (SF) scenario).

In November 2016, Ofcom received new data that enabled it to produce revised estimates for the number of premises that may be eligible for a potential USO. This data, using the information underpinning the 2016 Connected Nations report, had significant differences in the number and distribution of premises in comparison to that provided for our original modelling. Ofcom therefore asked Analysys Mason to reproduce our analysis for three of the scenarios in the original modelling (Scenario 1, Scenario 3 and the SF scenario) using these new premises estimates. This was published as an addendum to the Analysys Mason report in December 2016.

In February 2017, Analysys Mason was then asked to run an entirely new scenario assuming a 20Mbit/s downlink and 2Mbit/s uplink specification (the "20Mbit/s scenario"). This scenario was developed only using the revised premises estimates and therefore has no equivalent scenario in the original modelling. It is not related to Scenario 2 in the original modelling, which is not considered in this document.

In May 2017, following an investigation after a request from DCMS, adjustments were made to the FTTC coverage area calculation. The net effect of these adjustments is that more FTTC supplementary cabinets are deployed, increasing the deployment costs of FTTC (particularly VDSL2) and subsequently leading to a smaller proportion of FTTC VDSL2 being deployed in the lowest-cost-technology mix. The overall cost of this lowest-cost-technology mix is also higher.

This second addendum should be read in conjunction with the Analysys Mason report published in December 2016, which describes in detail the model methodology, its capabilities and its limitations.

Figure 1 below summarises the specification for each of the scenarios that Ofcom has asked Analysys Mason to run since the original modelling. We place the 20Mbit/s scenario requested by Ofcom between Scenario 3 and the Superfast (SF) scenario in our results, based on its specification.

Figure 1: Scenarios for broadband USO technical specification [Source: Ofcom, 2016–2017]

	Scenario 1	Scenario 3	20Mbit/s scenario	Superfast (SF) scenario
Download sync speed[1]	Sync speed 10Mbit/s – best efforts	Achieving at least a similar distribution of actual speeds as a current fixed service with 10Mbit/s predicted speed	Sync speed 20Mbit/s	Sync speed 30Mbit/s
Upload sync speed	None defined	1Mbit/s	2Mbit/s	6Mbit/s[2]
Latency	None defined	Medium Response Time	Medium Response Time	Fast Response Time
Contention ratio/ committed information rate (CIR)	None defined	50:1	50:1	10Mbit/s
Eligible premises in calculations for main report	*1.6 million*	*3.5 million*	*Not calculated*	*5.5 million*
Eligible premises in current version	*1.4 million*	*2.6 million*	*3.0 million*	*3.5 million*

In the rest of this document, we provide:

- The results from the current modelling of the scenarios in Figure 1, in Section 2
- The current data processing we have applied to the scenarios in Figure 1, in Section 3
- A comparison of the current results and the original modelling, in Section 4
- A description of how the results have evolved from the original modelling, in Section 5
- A sensitivity test of the current results to the assumed maximum route distance, in Section 6.

1 Sync speed is the maximum speed that the line between a subscriber's router and its parent exchange is capable of sustaining in the absence of any other traffic or traffic management policies.

2 This is the median for all superfast broadband lines, including Virgin Media.

2 Current results for the four scenarios

Figure 2 below summarises the total deployment costs currently estimated by the stylised cost model for the four scenarios defined in Figure 1.

Figure 2: Total deployment cost (GBP billion, 2016 real terms) [Source: Analysys Mason, 2017]

Technology	New Scenario 1	New Scenario 3	20Mbit/s scenario	New SF scenario
FWA – sub-1GHz	1.7	3.8	6.3	19.6
FWA – 5.8GHz	1.6	3.2	4.8	13.8
FTTC VDSL2	1.8	2.3	2.6	3.2
FTTC LR-VDSL	1.3	1.8	2.1	2.6
FTTP	7.0	7.9	8.2	8.8
Lowest-cost (access network only)	**1.1**	**1.6**	**1.8**	**2.4**
Lowest-cost (including core network) [3]	**1.1**	**1.7**	**1.9**	**2.4**
Number of eligible premises (million)	*1.4*	*2.6*	*3.0*	*3.5*
Number of eligible postcodes (million)	*0.19*	*0.31*	*0.35*	*0.44*

Figure 3 shows that the deployment cost per premises connected increases in each of the four scenarios calculated with the information underpinning the 2016 Connected Nations report.

Figure 3: Deployment cost per premises connected (GBP, 2016 real terms) [Source: Analysys Mason, 2017]

Technology	New Scenario 1	New Scenario 3	20Mbit/s scenario	New SF scenario
FWA – sub-1GHz	1562	1807	2654	6958
FWA – 5.8GHz	1506	1530	2053	4878
FTTC VDSL2	1613	1087	1112	1147
FTTC LR-VDSL	1168	869	872	906
FTTP	6417	3793	3483	3119
Lowest cost (access network only)	971	774	782	837

Figure 4 summarises the annualised cost of deploying and operating the network for each technology and for the lowest-cost technology mix.

Figure 4: Annualised cost (GBP million, 2016 real terms) [Source: Analysys Mason, 2017]

Technology	New Scenario 1	New Scenario 3	20Mbit/s scenario	New SF scenario
FWA – sub-1GHz	929	2067	3493	11200
FWA – 5.8GHz	893	1733	2673	7807
FTTC VDSL2	334	447	514	629

[3] Since core network related costs are less than GBP0.1 billion, including these core network costs to the nearest GBP0.1 billion can appear to leave total costs unchanged due to rounding effects.

Technology	New Scenario 1	New Scenario 3	20Mbit/s scenario	New SF scenario
FTTC LR-VDSL	253	372	420	516
FTTP	922	1069	1117	1209
Lowest cost (access network only)	**239**	**345**	**389**	**477**
Lowest cost (incl. core network)	**279**	**390**	**458**	**586**

2.1 Lowest-cost technology mix

Figure 5 summarises the proportion of premises covered by each technology if the lowest-cost technology (as measured in annualised cost terms) is deployed in each modelled area. FWA continues to be the highest-cost technology in annualised terms in each modelled area and so forms only a negligible part of the lowest-cost technology mix.

Figure 5: Lowest-cost technology mix (according to annualised cost) [Source: Analysys Mason, 2017]

Technology	New Scenario 1	New Scenario 3	20Mbit/s scenario	New SF scenario
FWA – 5.8GHz	0%	0%	0%	0%
FWA – sub 1GHz	0%	0%	0%	0%
FTTC VDSL2	69%	76%	73%	72%
FTTC LR-VDSL	26%	15%	19%	20%
FTTP GPON	5%	9%	8%	8%

Figure 6 summarises this in terms of total number of eligible lines. For the avoidance of doubt, these values are based on the *eligible lines output from the stylised cost model on a cabinet area basis*. The totals may differ slightly from the final input eligible lines stated in Section 3 due to rounding occurring within the calculations undertaken within the stylised cost model.

Figure 6: Lowest-cost technology mix in terms of millions of eligible lines (according to annualised cost) [Source: Analysys Mason, 2017]

Technology	New Scenario 1	New Scenario 3	20Mbit/s scenario	New SF scenario
FWA – 5.8GHz	0.00	0.00	0.00	0.00
FWA – sub 1GHz	0.00	0.00	0.00	0.00
FTTC VDSL2	0.93	1.92	2.10	2.43
FTTC LR-VDSL	0.36	0.39	0.55	0.69
FTTP GPON	0.06	0.23	0.24	0.27
Total	**1.35**	**2.55**	**2.89**	**3.39**

2.2 Core network costs

Figure 7 shows the national costs calculated for the core network for the four scenarios calculated using the information underpinning the 2016 Connected Nations report.

Figure 7: Core network costs (GBP million, 2016 real terms) [Source: Analysys Mason, 2017]

	New Scenario 1	New Scenario 3	20Mbit/s scenario	New SF scenario
Connection capex	38.7	41.7	56.5	68.9
Annual rental	35.8	41.3	62.7	102.4
Annualised cost	39.8	45.6	68.5	109.4

The core network costs (connection, annual rental and the annualised cost) behave intuitively: the increase from Scenario 1 to Scenario 3, Scenario 3 to the 20Mbit/s scenario and finally from the 20Mbit/s scenario to the SF scenario reflects the increasingly larger total number of subscribers in each exchange.

3 Consistent data processing for the four scenarios

We have processed the data for all four current scenarios (including the 20Mbit/s scenario) so that they could be fed into the stylised cost model in a similar way to the scenarios that are described in Annex B of our main report (i.e. as undertaken in our original modelling).

It is important to note that as part of our data processing for these current scenarios we restricted the new model runs to just those postcodes which already existed in the original datasets. This was in order to avoid carrying out further time-consuming geoanalysis work. This does reduce the accuracy of the stylised cost model results, although we do scale-up the deployment costs to take account of the excluded postcodes.

Below, the key features of the current scenarios are also compared to the previous versions of these scenarios as used in the original modelling.

We also describe the specific adjustments to the inputs that we have made for the new 20Mbit/s scenario.

3.1 Scenario 1

Restricting the modelling to only those geographical areas for which we had already carried out the required geoanalysis means that 2% of records are discarded, corresponding to 2% of postcodes and 1% of lines. As before, we infilled some mostly minor gaps in the remaining dataset, including:

- Infilled missing exchange data: 38
- Infilled missing cabinet coordinates: 5
- Infilled missing postcode coordinates: 0
- Where there was no cabinet ID but <100% exchange-only lines (EoLs), we updated the EoL eligible lines and non-EoL eligible lines to assume that all lines were EoLs: 468
- Missing cabinet distances infilled using straight-line distance (capped at 10km): 844
- Missing exchange distances infilled using straight-line distance (capped at 10km): 176 813, although we note that these are not directly used in the model.
- Areas divided by one million to convert to square kilometres: All

- Where there was a cabinet ID but a nonzero EoL, we updated the EoL eligible lines and non-EoL eligible lines to assume that no lines were EoL: 14 474.

Finally, the information was ordered by postcode when inserting into the model. Figure 8 below shows that the number of lines in Scenario 1 has reduced to 1.4 million, from 1.6 million in the previous version. The post-processing of the results scales the total deployment costs up, to account for these records being discarded.

	Old Scenario 1	New Scenario 1
Total records	252 490	226 446
Total records (after discard)	252 490 (100%)	221 033 (98%)
Total unique postcodes	210 233	190 619
Total unique postcodes (after discard)	210 233 (100%)	186 259 (98%)
Total unique lines	1 607 237	1 368 077
Total unique lines (after discard and grouping)	1 606 754 (100%)	1 351 333 (99%)

Figure 8: Key scenario input statistics for the current Scenario 1 [Source: Analysys Mason, 2017]

3.2 Scenario 3

Restricting the modelling to only those geographical areas for which we had already carried out the required geoanalysis means that 6% of records are discarded, corresponding to 5% of postcodes and 3% of lines. As before, we infilled some mostly minor gaps in the remaining dataset, including:

- Infilled missing exchange data: 74
- Infilled missing cabinet coordinates: 83
- Infilled missing postcode coordinates: 33
- Where there was no cabinet ID but <100% EoLs, we updated the EoL eligible lines and non-EoL eligible lines to assume that all lines were EoL: 553
- Missing cabinet distances infilled using straight-line distance (capped at 10km): 1014
- Missing exchange distances infilled using straight-line distance (capped at 10km): 247 370, although we note that these are not directly used in the model
- Areas divided by one million to convert to square kilometres: All
- Where there was a cabinet ID but a nonzero EoL, we updated the EoL eligible lines and non-EoL eligible lines to assume that no lines were EoL: 33 111.

Finally, the information was ordered by postcode when inserting into the model. Figure 9 below shows that the number of lines in Scenario 3 has reduced to 2.6 million from 3.5 million in the previous version. The post-processing of the results scales the total deployment costs up, to account for these records being discarded.

	Old Scenario 3	New Scenario 3
Total records	430 056	360 735
Total records (after discard)	460 056 (100%)	340 440 (94%)
Total unique postcodes	371 586	309 005
Total unique postcodes (after discard)	371 586 (100%)	292 021 (95%)
Total unique lines	3 542 695	2 609 736
Total unique lines (after discard and grouping)	3 542 022 (100%)	2 544 306 (97%)

Figure 9: Key scenario input statistics for the current Scenario 3 [Source: Analysys Mason, 2017]

3.3 20Mbit/s scenario

Restricting the modelling to only those geographical areas for which we had already carried out the required geo-analysis means that 5% of records are discarded, corresponding to 5% of postcodes and 2% of lines.

This scenario did not exist in the original modelling underpinning the main report. Below, we describe the key input statistics. As with the other scenarios, we infilled some mostly minor gaps in the remaining dataset. This included:

- Infilled missing exchange data: 75
- Infilled missing cabinet coordinates: 86
- Infilled missing postcode coordinates: 34
- Where there was no cabinet ID but <100% EoLs, we updated the EoL eligible lines and non-EoL eligible lines to assume that all lines were EoL: 553
- Missing cabinet distances infilled using straight-line distance (capped at 10km): 1110
- Missing exchange distances infilled using straight-line distance (capped at 10km): 295 476, although we note that these are not directly used in the model.
- Areas divided by one million to convert to square kilometres: All
- Where there was a cabinet ID but a nonzero EoL, we updated the EoL eligible lines and non-EoL eligible lines to assume that no lines were EoL: 33 358.

Finally, the information was ordered by postcode when inserting into the model. Figure 10 below shows that the number of lines in the 20Mbit/s scenario is 3.0 million. The post-processing of the results scales the total deployment costs up, to account for these records being discarded.

	20Mbit/s scenario
Total records	410 128
Total records (after discard)	388 908 (95%)
Total unique postcodes	349 907
Total unique postcodes (after discard)	332 256 (95%)
Total unique lines	2 950 311
Total unique lines (after discard and grouping)	2 882 877 (98%)

Figure 10: Key scenario input statistics for the current 20Mbit/s scenario [Source: Analysys Mason, 2017]

Although the specification for the 20Mbit/s scenario is largely based on Scenario 2, due to the increased downlink and uplink throughput requirements we have made some specific adjustments, as we summarise in Figure 11 below. We have chosen to double the access/core CIR compared to the values assumed in Scenarios 2 and 3, as the approach for the 20Mbit/s scenario has been to consider it as a modification of Scenario 2 (with a doubling of the throughput in the specification).

Input	Scenario 3	20Mbit/s scenario	SF scenario
Access CIR (Mbit/s)	1.50	3.00	10.00
Core CIR (Mbit/s)	1.50	3.00	10.00
FWA high-frequency cell radius (metres)[4]	1000	707	500
LR-VDSL range (metres)	3500	2510	1800
VDSL2 range (metres)	1900	1572	1300

Figure 11: Inputs changed for the current 20Mbit/s scenario [Source: Analysys Mason, 2017]

3.4 Superfast scenario

Restricting the modelling to only those geographical areas for which we had already carried out the required geoanalysis means that 12% of records are discarded, corresponding to 12% of postcodes and 4% of lines.

As before, we infilled some mostly minor gaps in the remaining dataset, including:

- Infilled missing exchange data: 87
- Infilled missing cabinet coordinates: 89
- Infilled missing postcode coordinates: 34
- Where there was no cabinet ID but <100% EoL, we updated the EoL eligible lines and non-EoL eligible lines to assume that all lines were EoL: 553
- Missing cabinet distances infilled using straight-line distance (capped at 10km): 1324

[4] The low-frequency radius is assumed to be the same for Scenario 3 and the Superfast scenario, and therefore we assume the same radius for the 20Mbit/s scenario as well.

- Missing exchange distances infilled using straight-line distance (capped at 10km): 368 948, although we note these are not directly used in the model
- Areas divided by one million to convert to square kilometres: All
- Where there was a cabinet ID but a nonzero EoL, we updated the EoL eligible lines and non-EoL eligible lines to assume that no lines were EoL: 33 658.

Finally, the information was ordered by postcode when inserting into the model. Figure 12 below shows that the number of lines in the Superfast scenario has reduced to 3.5 million from 5.5 million in the previous version. The post-processing of the results scales the total deployment costs up to account for these records being discarded.

	Old SF scenario	New SF scenario
Total records	586 811	524 988
Total records (after discard)	586 811 (100%)	462 777 (88%)
Total unique postcodes	493 786	444 803
Total unique postcodes (after discard)	493 786 (100%)	393 560 (88%)
Total unique lines	5 494 597	3 528 594
Total unique lines (after discard and grouping)	5 494 362 (100%)	3 389 080 (96%)

Figure 12: Key scenario input statistics for the current Superfast scenario [Source: Analysys Mason, 2017]

4 Evolution of the model outputs

In this section, we provide more context on how the results of the stylised cost model have evolved since the original modelling. We then illustrate the evolution of the key outputs for each of the four current scenarios.

4.1 Timing of changes

The timing of the main changes is summarised below in Figure 13.

Figure 13: Timing of main changes [Source: Analysys Mason, 2017]

Timing	Description of changes	Postcode databases	Scenarios calculated
Original modelling	Original modelling of Scenarios 1, 2, 3 and SF	Original "postcode databases" (of eligible premises by postcode, as provided by Ofcom) are post-processed by Analysys Mason	• Old Scenario 1 • Old Scenario 2 • Old Scenario 3 • Old SF scenario
Late 2016	Postcode databases, refined using new information from the 2016 Connected Nations report	Revised postcode databases are post-processed by Analysys Mason, in-filling in places (e.g. cabinet distances)	• New Scenario 1 • New Scenario 3 • New SF scenario

Timing	Description of changes	Postcode databases	Scenarios calculated
		using the original postcode databases	
February 2017	20Mbit/s scenario calculated for first time	Postcode database is post-processed by Analysys Mason without reference to original databases (as one did not exist for this scenario)	20Mbit/s scenario
May 2017	Postcode databases for New Scenarios 1, 3 and SF post-processed again Corrections in FTTC coverage area calculation	Revised postcode databases from late 2016 are post-processed again by Analysys Mason, this time without reference to the original databases	• New Scenario 1 • New Scenario 3 • 20Mbit/s scenario • New SF scenario

The adjustments undertaken in May 2017, as referenced above, arose following further review of the stylised cost model after a request from DCMS to quantify the number of additional cabinets deployed in each scenario in the FTTC modelling.

When investigated, the number of cabinets indicated unusual behaviour between the 20Mbit/s and SF scenarios, although this only became apparent when we inspected the number of supplementary cabinets being deployed (rather than total cabinets) and also only when comparing the 20Mbit/s scenario as an intermediate step between Scenario 3 and the SF scenario. In order to enable a true comparison of the four scenarios, it was therefore deemed important to process the postcode databases for all four scenarios in the same way, meaning that the databases for Scenarios 1, 3 and SF were reprocessed in a consistent fashion with the 20Mbit/s scenario. The cell radii assumed for LR–VDSL in the SF scenario was also amended to be 1.8km, consistent with the source cited in Section 2.2.2 of the published Analysys Mason report.[5]

Figure 14 provides the current cabinet deployments derived in the stylised cost model for each of the four scenarios. In particular, it shows that the modelled number of supplementary cabinets increases as the service specification requirements become more onerous across the four scenarios.

[5] http://www.ispreview.co.uk/index.php/2016/04/bt-openreach-prep-trial-long-reach-vdsl-broadband.html

Figure 14: Current number of cabinets (thousands) modelled in the USO footprint using FTTC [Source: Analysys Mason, 2017]

Cabinets deployed in the stylised cost model (thousands)	Scenario 1	Scenario 3	20Mbit/s scenario	New SF scenario
FTTC VDSL2 only deployment by the stylised cost model				
Existing cabinets that would be upgraded	39	56	61	70
Supplementary cabinets to be deployed	16	17	23	31
TOTAL	**55**	**74**	**84**	**101**
FTTC LR-VDSL only deployment by the stylised cost model				
Existing cabinets that would be upgraded	39	57	62	70
Supplementary cabinets to be deployed	6	8	11	17
TOTAL	45	65	73	87

The next two sections compare the total deployment cost and lowest-cost technology mix for each scenario in turn over the course of these changes, which highlight other aspects where comparison of the results across the four scenarios improves following the adjustments identified.

4.2 Evolution in total deployment cost

The following four figures show how the total deployment costs for each of the four scenarios has evolved since the original modelling was undertaken.

Figure 15: Deployment cost (GBP billion, 2016 real terms) for the original modelling [Source: Analysys Mason, 2017]

Technology	Scenario 1	Scenario 3	20Mbit/s scenario	New SF scenario
FWA – sub-1GHz	2.0	4.8	Not calculated	29.9
FWA – 5.8GHz	1.9	4.0	Not calculated	20.7
FTTC VDSL2	1.7	2.2	Not calculated	2.8
FTTC LR-VDSL	1.4	2.0	Not calculated	2.5
FTTP	7.2	8.5	Not calculated	9.6
Lowest-cost (access only)	**1.2**	**1.8**	Not calculated	**2.4**
Lowest-cost (including core network)	**1.2**	**1.9**	Not calculated	**2.5**

Figure 16: Deployment cost (GBP billion, 2016 real terms) in late 2016 [Source: Analysys Mason, 2017]

Technology	Scenario 1	Scenario 3	20Mbit/s scenario	New SF scenario
FWA – sub-1GHz	1.7	3.8	Not calculated	19.6
FWA – 5.8GHz	1.6	3.2	Not calculated	13.8
FTTC VDSL2	1.6	2.0	Not calculated	2.3
FTTC LR-VDSL	1.2	1.8	Not calculated	2.0
FTTP	7.2	8.0	Not calculated	8.8
Lowest-cost (access only)	**1.0**	**1.6**	Not calculated	**1.9**
Lowest-cost (including core network)	**1.1**	**1.6**	Not calculated	**2.0**

Figure 17: Deployment cost (GBP billion, 2016 real terms) in February 2017 [Source: Analysys Mason, 2017]

Technology	Scenario 1	Scenario 3	20Mbit/s scenario	New SF scenario
FWA – sub-1GHz	1.7	3.8	6.3	19.6
FWA – 5.8GHz	1.6	3.2	4.8	13.8
FTTC VDSL2	1.6	2.0	2.3	2.3
FTTC LR-VDSL	1.2	1.8	1.9	2.0
FTTP	7.2	8.0	8.2	8.8
Lowest-cost (access only)	**1.0**	**1.6**	**1.8**	**1.9**
Lowest-cost (including core network)	**1.1**	**1.6**	**1.8**	**2.0**

Figure 18: Current deployment cost (GBP billion, 2016 real terms) [Source: Analysys Mason, 2017]

Technology	Scenario 1	Scenario 3	20Mbit/s scenario	New SF scenario
FWA – sub-1GHz	1.7	3.8	6.3	19.6
FWA – 5.8GHz	1.6	3.2	4.8	13.8
FTTC VDSL2	1.8	2.3	2.6	3.2
FTTC LR-VDSL	1.3	1.8	2.1	2.6
FTTP	7.0	7.9	8.2	8.8
Lowest-cost (access only)	**1.1**	**1.6**	**1.8**	**2.4**
Lowest-cost (including core network)	**1.1**	**1.7**	**1.9**	**2.4**

As can be seen in Figure 17, there was no marked increase in FTTC costs between the 20Mbit/s scenarios and the SF scenario (in the case of FTTC VDSL2, both values were GBP2.3 billion above, whilst for FTTC LR–VDSL the value increased from GBP1.9 billion to GBP2.0 billion).

In the current results shown in Figure 18, there is now an increase in FTTC VDSL2 costs between the 20Mbit/s scenarios and the SF scenario (from GBP2.6 billion to GBP3.2 billion), as well as for FTTC LR–VDSL (from GBP2.1 billion to GBP 2.6 billion).

The change in costs by scenario resulting from the adjustments after February 2017 are summarised below in Figure 19. As can be seen below, the impact is primarily in an increase in calculated FTTC costs, but the percentage increase on the overall lowest-cost technology mix is smaller. The largest impact is on the results for the SF scenario.

Figure 19: Total deployment cost (GBP billion, 2016 real terms) [Source: Analysys Mason, 2017]

	Scenario 1		Scenario 3		20Mbit/s scenario		SF scenario	
Technology	**Feb 2017**	**Current**	**Feb 2017**	**Current**	**Feb 2017**	**Current**	**Feb 2017**	**Current**
FWA – sub-1GHz	1.7	1.7	3.8	3.8	6.3	6.3	19.6	19.6
FWA – 5.8GHz	1.6	1.6	3.2	3.2	4.8	4.8	13.8	13.8
FTTC VDSL2	1.6	1.8 (+13%)	2.0	2.3 (+13%)	2.3	2.6 (+14%)	2.3	3.2 (+43%)
FTTC LR-VDSL	1.2	1.3 (+4%)	1.8	1.8 (+2%)	1.9	2.1 (+7%)	2.0	2.6 (+25%)
FTTP	7.2	7.0 (-2%)	7.9	7.9	8.2	8.2	8.8	8.8
Lowest-cost (access only)	**1.0**	**1.1 (+2%)**	**1.6**	**1.6 (+1%)**	**1.8**	**1.8 (+5%)**	**1.9**	**2.4 (+23%)**
Lowest-cost (inc. core)	**1.1**	**1.1 (+2%)**	**1.6**	**1.7 (+1%)**	**1.8**	**1.9 (+5%)**	**2.0**	**2.4 (+22%)**

4.3 Evolution in lowest-cost technology mix

The following four figures show how the lowest-cost technology mix for each of the four scenarios has evolved since the original modelling was undertaken.

Figure 20: Lowest-cost technology mix (per annualised cost) for the original modelling [Source: Analysys Mason, 2017]

Technology	Scenario 1	Scenario 3	20Mbit/s scenario	New SF scenario
FWA – sub-1GHz	–%	–%	Not calculated	–%
FWA – 5.8GHz	–%	–%	Not calculated	–%
FTTC VDSL2	75%	80%	Not calculated	84%
FTTC LR-VDSL	20%	15%	Not calculated	11%
FTTP	5%	5%	Not calculated	5%

Figure 21: Lowest-cost technology mix (per annualised cost) as of late 2016 [Source: Analysys Mason, 2017]

Technology	Scenario 1	Scenario 3	20Mbit/s scenario	New SF scenario
FWA – sub-1GHz	–%	–%	Not calculated	–%
FWA – 5.8GHz	–%	–%	Not calculated	–%
FTTC VDSL2	74%	80%	Not calculated	83%
FTTC LR-VDSL	21%	11%	Not calculated	10%
FTTP	4%	9%	Not calculated	7%

Figure 22: Lowest-cost technology mix (per annualised cost) in February 2017 [Source: Analysys Mason, 2017]

Technology	Scenario 1	Scenario 3	20Mbit/s scenario	New SF scenario
FWA – sub-1GHz	–%	–%	–%	–%
FWA – 5.8GHz	–%	–%	–%	–%
FTTC VDSL2	74%	80%	75%	83%
FTTC LR-VDSL	21%	11%	17%	10%
FTTP	4%	9%	8%	7%

Figure 23: Current lowest-cost technology mix (per annualised cost) [Source: Analysys Mason, 2017]

Technology	Scenario 1	Scenario 3	20Mbit/s scenario	New SF scenario
FWA – sub-1GHz	0%	0%	0%	0%
FWA – 5.8GHz	0%	0%	0%	0%
FTTC VDSL2	69%	76%	73%	72%
FTTC LR-VDSL	26%	15%	19%	20%
FTTP	5%	9%	8%	8%

As can be seen in Figure 22 above, the proportions of eligible premises served by FTTC VDSL2 fluctuated between Scenario 3 (80%), the 20Mbit/s scenario (75%) and the SF scenario (83%), whereas the current results in Figure 23 show a consistently decreasing proportion of eligible premises served by FTTC VDSL2 across those scenarios. Similarly, the proportions derived for FTTC LR-VDSL fluctuated for these scenarios in Figure 22 but consistently increase in Figure 23.

5 Comparison of the scenarios from the original modelling and their current equivalents

Figure 24 below summarises the total deployment costs estimated by the stylised cost model for the current scenarios, compared to those calculated in the original modelling. This suggests that the current set of eligible premises in Scenario 1, Scenario 3 and the Superfast scenario are cheaper to serve for all technologies compared to the eligible premises in the original modelling.

Figure 24: Total deployment cost (GBP billion, 2016 real terms) [Source: Analysys Mason, 2017]

Technology	Old Scn1	New Scn1	Old Scn3	New Scn3	Old SF scenario	New SF scenario
FWA – sub-1GHz	2.0	1.7 (-13%)	4.8	3.8 (-21%)	29.9	19.6 (-34%)
FWA – 5.8GHz	1.9	1.6 (-13%)	4.0	3.2 (-20%)	20.7	13.8 (-34%)
FTTC VDSL2	1.7	1.8 (+2%)	2.2	2.3 (+2%)	2.8	3.2 (+17%)
FTTC LR-VDSL	1.4	1.3 (-3%)	2.0	1.8 (-9%)	2.5	2.6 (+3)
FTTP	7.2	7.0 (–10%)	8.5	7.9 (-7%)	9.6	8.8 (-8%)
Lowest-cost (access network only)	**1.2**	**1.1 (-10%)**	**1.8**	**1.6 (-11%)**	**2.4**	**2.4 (+2%)**
Lowest-cost (including core network)	**1.2**	**1.1 (-11%)**	**1.9**	**1.7 (-12%)**	**2.5**	**2.4 (-2%)**
Number of eligible premises (million)	*1.6*	*1.4 (-15%)*	*3.5*	*2.6 (-15%)*	*5.5*	*3.5 (-36%)*
Number of eligible postcodes (million)	*0.210*	*0.191 (-9%)*	*0.372*	*0.309 (-17%)*	*0.494*	*0.445 (-10%)*

Figure 25 shows that the deployment cost per premises connected increases in each of the three scenarios. This is because the number of eligible premises in each current scenario has fallen more significantly than the area requiring coverage (e.g. as expressed in terms of number of postcodes containing eligible premises). This means that the network assets have not reduced, in the same proportion as the number of eligible premises, between the scenarios in the original modelling and the current scenarios.

Figure 25: Deployment cost per premises connected (GBP, 2016 real terms) [Source: Analysys Mason, 2017]

Technology	Old Scn1	New Scn1	Old Scn3	New Scn3	Old SF scenario	New SF scenario
FWA – sub-1GHz	1524	1562	1682	1807	6812	6958
FWA – 5.8GHz	1466	1506	1402	1530	4723	4878
FTTC VDSL2	1346	1613	790	1087	630	1147
FTTC LR-VDSL	1090	1168	704	869	562	906
FTTP	5632	6417	3011	3793	2173	3119
Lowest cost (access network only)	922	971 (+5%)	644	774 (+23%)	535	837 (+56%)

Figure 26 summarises the annualised cost of deploying and operating the network for each technology and for the lowest-cost technology mix.

Figure 26: Annualised cost (GBP million, 2016 real terms) [Source: Analysys Mason, 2017]

Technology	Old Scn1	New Scn1	Old Scn3	New Scn3	Old SF scenario	New SF scenario
FWA – sub-1GHz	1063	929	2601	2067	17071	11200
FWA – 5.8GHz	1019	893	2143	1733	11763	7807
FTTC VDSL2	336	334	462	447	586	629
FTTC LR-VDSL	281	253	422	372	537	516
FTTP	959	922	1173	1069	1348	1209
Lowest cost (access network only)	**265**	**239 (-10%)**	**396**	**345 (-13%)**	**507**	**477 (-6%)**
Lowest cost (incl. core network)	**313**	**279 (-11%)**	**455**	**390 (-14%)**	**701**	**586 (-16%)**

5.1 Lowest-cost technology mix

Figure 27 summarises the proportion of premises covered by each technology if the lowest-cost technology (as measured in annualised cost terms) is deployed in each modelled area. FWA continues to be the highest-cost technology in annualised terms in each modelled area and so forms only a negligible part of the lowest-cost technology mix.

Figure 27: Lowest-cost technology mix (according to annualised cost) [Source: Analysys Mason, 2017]

	Old Scn1	New Scn1	Old Scn3	New Scn3	Old SF scenario	New SF scenario
FWA – 5.8GHz	–%	0%	–%	0%	–%	0%
FWA – sub 1GHz	–%	0%	–%	0%	–%	0%
FTTC VDSL2	75%	69%	80%	76%	84%	72%
FTTC LR-VDSL	20%	26%	15%	15%	11%	20%
FTTP GPON	5%	5%	5%	9%	5%	8%

5.2 Core network costs

Figure 28 shows the national costs calculated for the core network from both the original modelling and the current scenarios.

Figure 28: Core network costs (GBP million, 2016 real terms) [Source: Analysys Mason, 2017]

	Old Scn1	New Scn1	Old Scn3	New Scn3	Old SF scenario	New SF scenario
Connection capex	46.7	38.7 (-17%)	53.1	41.7 (-21%)	120.8	68.9 (-43%)
Annual rental	43.2	35.8 (-17%)	54.1	41.3 (-24%)	181.4	102.4 (-43%)
Annualised cost	47.9	39.8 (-17%)	59.4	45.6 (-23%)	193.6	109.4 (-43%)

The core network costs (connection, annual rental and the annualised cost) behave intuitively: the decrease in each scenario reflects the smaller total number of subscribers in each exchange.

The savings are larger in Scenario 3 and the Superfast scenario, reflecting the relatively larger number of premises and larger CIR requirement.[6] This means that a larger portion of the overall core network costs for each exchange are variable and hence more savings are available when the number of subscribers is decreased.

5.3 Conclusions

The magnitude of the costs now estimated by the stylised cost model is different from those in the original modelling, reflecting the updated premises data. However, the current results do not lead us to conclude that any updates are required to the key findings of our original modelling, nor our first addendum.

Figure 3 shows that the deployment cost per premises connected increases in each of the four scenarios calculated with the information underpinning the 2016 Connected Nations report.

6 CIR in the core is 0.5Mbit/s for Scenario 1, 1.5Mbit/s for Scenario 3 and 10Mbit/s for the Superfast scenario.

6 Sensitivity testing of a longer maximum route distance assumption

As indicated on pages 58/59 of the Analysys Mason report, fibre feeder requirements are derived based on the shortest road route distance from the postcode centroid in the postcode group that is closest to the parent exchange back to the parent exchange. This distance is capped at 2km since we understand 96% of premises are believed to be within 2km of a next-generation access (NGA) aggregation node.

Since this cap (effectively, a zone radius) of 2km applies to 96% of all premises, it could be the case that the majority of eligible USO premises would only lie within a larger zone radius. We have therefore sensitivity tested both the 20Mbit/s scenario and the SF scenario, assuming a cap of 10km rather than 2km. Figure 29 compares the total deployment cost by technology for these cases. This sensitivity test only impacts the FTTC and FTTP technologies.

Figure 29: Total deployment cost (GBP billion, 2016 real terms) [Source: Analysys Mason, 2017]

Technology	20Mbit/s scenario (2km)	20Mbit/s scenario (10km)	New SF scenario (2km)	New SF scenario (10km)
FWA – sub-1GHz	6.3	6.3	19.6	19.6
FWA – 5.8GHz	4.8	4.8	13.8	13.8
FTTC VDSL2	2.6	3.4	3.2	4.3
FTTC LR-VDSL	2.1	2.5	2.6	3.2
FTTP	8.2	8.8	8.8	9.5
Lowest-cost (access network only)	**1.8**	**2.0**	**2.4**	**2.8**
Lowest-cost (including core network)	**1.9**	**2.1**	**2.4**	**2.8**

This increases the lowest-cost deployment level by 9% for the 20Mbit/s scenario and the SF scenario by 16%.

Figure 30 shows that the deployment cost per premises connected.

Figure 30: Deployment cost per premises connected (GBP, 2016 real terms) [Source: Analysys Mason, 2017]

Technology	20Mbit/s scenario (2km)	20Mbit/s scenario (10km)	New SF scenario (2km)	New SF scenario (10km)
FWA – sub-1GHz	2654	2654	6958	6958
FWA – 5.8GHz	2053	2053	4878	4878
FTTC VDSL2	1112	1442	1147	1515
FTTC LR-VDSL	872	1061	906	1132
FTTP	3483	3743	3119	3354
Lowest cost (access network only)	782	853	837	974

Figure 31 summarises the annualised cost of deploying and operating the network for each technology and for the lowest-cost technology mix.

Figure 31: Annualised cost (GBP million, 2016 real terms) [Source: Analysys Mason, 2017]

Technology	20Mbit/s scenario (2km)	20Mbit/s scenario (10km)	New SF scenario (2km)	New SF scenario (10km)
FWA – sub-1GHz	3493	3493	11200	11200
FWA – 5.8GHz	2673	2673	7807	7807
FTTC VDSL2	514	624	629	777
FTTC LR-VDSL	420	483	516	607
FTTP	1117	1205	1209	1303
Lowest cost (access network only)	**389**	**443**	**477**	**549**
Lowest cost (incl. core network)	**458**	**511**	**586**	**659**

Figure 32 summarises the proportion of premises covered by each technology if the lowest-cost technology (as measured in annualised cost terms) is deployed in each modelled area.

Figure 32: Lowest-cost technology mix (according to annualised cost) [Source: Analysys Mason, 2017]

Technology	20Mbit/s scenario (2km)	20Mbit/s scenario (10km)	New SF scenario (2km)	New SF scenario (10km)
FWA – 5.8GHz	0%	0%	0%	0%
FWA – sub 1GHz	0%	0%	0%	0%
FTTC VDSL2	73%	71%	72%	70%
FTTC LR-VDSL	19%	19%	20%	20%
FTTP GPON	8%	10%	8%	10%