
Promoting competition and investment in fibre networks

Initial consultation on the approach to modelling the
costs of a fibre network

CONSULTATION:

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1. Overview

- 1.1 Demand for fixed and mobile broadband connections is growing rapidly, from both people and businesses. To meet this demand, sizeable investment is needed to upgrade the UK's broadband infrastructure. Whether to support fibre to the home broadband, connections to 5G mobile stations, or seamless business connectivity, more fibre networks will be needed to support the next generation of services in the UK. The UK Government has also signaled strong support for fibre networks and wants 15 million premises to be connected by 2025.
- 1.2 In February 2016 we published our initial conclusions from the Strategic Review of Digital Communications ("the DCR"). We explained that one of our strategic objectives is to promote the interests of consumers by encouraging the large-scale deployment of new fibre networks in support of providing competing ultrafast broadband services.
- 1.3 Given our strategy, we consider that it will be increasingly important to understand the costs of deploying fibre networks to support our future regulatory decisions. Understanding the cost of deploying a fibre network will help us determine the likelihood of competition emerging in a particular area. It will also help us to design charge control remedies that fulfil the objectives we set out in our March 2019 Approach to Remedies consultation.¹

What we are proposing – in brief

In this document, we set out initial proposals on our approach to modelling the costs of services provided over a fibre network. Specifically:

- (i) We intend to use a bottom-up modelling approach to estimate the costs of building an efficient fibre network;
- (ii) We set out the proposed design of the modelled fibre network; and
- (iii) We set out proposals regarding the design of the cost model.

This overview is a simplified high-level summary only. The proposals we are consulting on and our reasoning are set out in the full document.

- 1.4 This consultation closes on 2 August 2019.

Background

- 1.5 As demand for data continues to grow, our strategy is to secure investment in fibre networks by promoting network-based competition, so people and businesses can access the ultrafast, reliable connections they need. Fibre technology will be critical in delivering

¹ Promoting competition and investment in fibre networks, Initial Proposals – Approach to remedies, March 2019, <https://www.ofcom.org.uk/consultations-and-statements/category-1/promoting-investment-competition-fibre-networks-approach-remedies>

better broadband for people and businesses, and providing connections to current 4G, and new 5G, mobile base stations. Fibre broadband delivers faster speeds than copper-based services, greater stability at peak times and lower fault rates.

1.6 We believe that competition between different networks is the best way to drive investment in high-quality, innovative services and keep prices down. Our view is that over the next five to ten years there is potential for significant investment in new fibre networks by BT and rival network providers.

1.7 In July 2018, we set out our plans to provide longer-term regulatory certainty and support for competition and investment in fibre networks across the UK. We said:

- We would look to introduce regulation allowing unrestricted access to Openreach's duct and pole infrastructure.
- We would look to vary regulation by geography since competition and investment will vary by geography,
- We would look to regulate residential and business markets more holistically, bringing together our assessments into a single review, lasting at least five years instead of three.

1.8 Since then we have taken the following steps to further our plans:

- In December 2018, we published our approach to geographic markets, we set out our initial proposals on categorising areas of the country according to the competitive conditions that exist in those areas.² We proposed three categories of geographic area for the purposes of targeting our *ex ante* regulation:
 - **Geographic area 1 – competitive areas:** that are effectively competitive where we would not impose regulation;
 - **Geographic area 2 – potentially competitive areas:** where non-BT fibre networks are being built, or where there are reasonable prospects of them being built and therefore *ex ante* regulation needs to reflect this potential for competitive investment; and
 - **Geographic area 3 – non-competitive areas:** where we think non-BT fibre networks will not be built to any material extent and therefore *ex ante* regulation should focus on BT's investment.
- In March 2019, we published our initial proposals on the key remedies that we consider will need to be imposed on BT, in the event of an SMP finding, in the fixed telecoms markets from April 2021.³ In our consultation, we proposed different *ex ante* regulation in potentially competitive areas and non-competitive areas.

² Promoting investment and competition in fibre networks, Approach to geographic markets, December 2018.

<https://www.ofcom.org.uk/consultations-and-statements/category-1/promoting-investment-competition-fibre-networks>

³ Promoting competition and investment in fibre networks, Initial Proposals, Approach to remedies, March 2019

<https://www.ofcom.org.uk/consultations-and-statements/category-1/promoting-investment-competition-fibre-networks-approach-remedies>

- In May 2019, we published a Draft Statement that proposes to require Openreach to offer unrestricted access to its duct and pole infrastructure.⁴
- 1.9 We do not expect to make our final proposals in relation to defining markets, assessing SMP and setting regulatory remedies in the fixed telecoms markets until the end of 2019. However, given our strategic objective to promote the interests of consumers by encouraging the deployment of new fibre networks, and our initial proposals for setting remedies, we consider that it will be increasingly important to understand the costs of deploying fibre networks to support our future regulatory decisions.
- 1.10 For example, in relation to our initial proposals in the March 2019 Approach to remedies consultation, understanding the costs of deploying a fibre network will be important to:
- Ensure our regulation is supportive of investment in competing fibre networks in potentially competitive areas; and
 - Encourage BT to invest in fibre networks in non-competitive areas under the proposed RAB style regulation.
- 1.11 Therefore, while we are still assessing competition in fixed telecoms markets, to inform our work on the Fixed Telecoms Market Review, and to be able to consult fully on all options for future remedies to the extent we find any telecoms provider to have significant market power (SMP), we are consulting on an approach to modelling the costs of a fibre network now.

This document

- 1.12 In this consultation, we are providing our initial proposals on our approach to modelling a fibre network; and the structure of a fibre cost model.
- 1.13 Alongside this consultation we have published a spreadsheet model (“the model”). We have also published a report prepared by Cartesian which describes the network and cost module components of the model in more detail.
- 1.14 We are not consulting on the level of costs calculated by the model. The model is populated with indicative data only that we will update with data collected using our information gathering powers. Therefore, while the model is able to generate “unit costs” for services provided over a fibre network, this capability is provided at this time so interested stakeholders are able to see the impact of changing model assumptions. The input numbers are placeholders only and the outputs of the model do not provide the basis for any potential future regulation and do not represent a proposal.

Next steps

- 1.15 This consultation closes on 2 August 2019.

⁴ Promoting competition and investment in fibre networks, Draft Statement, Review of the physical infrastructure and business connectivity markets, May 2019 <https://www.ofcom.org.uk/consultations-and-statements/category-1/review-physical-infrastructure-and-business-connectivity-markets>

Promoting competition and investment in fibre networks

- 1.16 We expect to publish a further version of the model as part of our Fixed Telecoms Market Review proposals document in December 2019.

2. Our general approach

The aim of our modelling exercise

- 2.1 At a high level, our modelling aim is to better understand the costs of deploying a network that offers a range of services over a common underlying fibre infrastructure.
- 2.2 At a more detailed level, we are also looking to understand:
 - The costs of deploying a fibre network in different geographic areas and at different scales and network configurations.
 - The costs of individual services to both residential and business customers provided over a fibre network (and how these vary by geography and scale of the network).
 - How the costs of deploying a fibre network vary in response to a decision to re-use existing physical infrastructure (i.e. using Duct and Pole Access (DPA)) as opposed to building physical infrastructure.
- 2.3 In the remainder of this section, we set out our proposed approach for key modelling choices and set out the overall structure of the proposed model as well as possible approaches to calibrating this model.
- 2.4 In subsequent sections, we provide more detail on our proposed approach to modelling service volumes, dimensioning and costing the modelled network, and determining how modelled costs should be recovered over time and across services.

Key modelling choices

Bottom up approach to modelling

- 2.5 We could model the costs of deploying a fibre network using either a bottom-up approach or a top-down approach to modelling.
 - a) A bottom-up model estimates how much network equipment is needed for a forecast level of volumes or traffic (based on technical assumptions in relation to network capacity and dimensioning algorithms). It then calculates the total cost of this network equipment using evidence of the capital and operating costs of each piece of equipment.
 - b) A top-down model uses total network cost data and allocates these costs to services based on service usage factors. It does not rely on detailed assumptions about how the network is constructed. Instead, the modelled costs are calculated using cost-volume elasticities which reflect assumptions about the way the cost of high-level network components change as traffic rises or falls.
- 2.6 We propose to take a bottom-up approach to modelling a fibre network. We consider that a bottom-up approach provides better flexibility to assess the costs across different geographies and for different scales of deployment. In addition, we note that it would be

difficult to conduct top-down modelling for estimating the costs of a large-scale fibre network since a large-scale fibre network does not exist yet in the UK (and therefore total network cost information would be unavailable).

- 2.7 As explained below, we propose to calibrate our bottom-up cost modelling using information from telecoms providers' business plans, as well as using information relating to actual network rollout to the extent that this is available.

Services and network scope

Services in scope

- 2.8 We consider that fibre networks will be able to offer a wide range of services, to both residential and business customers.
- 2.9 We propose to model a fibre network that offers the following types of services:
- a) Fibre to the premises (FTTP) services
 - b) Leased line services using Ethernet and/or WDM⁵ technology
 - c) Dark fibre services
- 2.10 We are not modelling the costs of Duct and Pole Access. However, we propose to include duct and poles access services in the mix of services in scope. This is because, although we do not expect all new fibre networks to supply these services, we are interested in understanding how the provision of these services may impact the unit costs of supplying downstream services over the fibre network.

Network scope

- 2.11 We propose to limit the span of the modelled network to the following network segments:
- The segment from the Access Node (Exchange) to the premises, for all the services in scope (e.g. FTTP; Ethernet and Optical Leased Lines; Dark Fibre; and Duct and Pole Access).
 - The segment from the Access Node to an Aggregation Node (i.e. Inter-Exchange fibre connections to deliver dedicated business services using leased lines or dark fibre).

Deploying fibre networks in different geographic areas and at different scales

- 2.12 We are interested in assessing the costs of deploying a fibre network across different geographic areas, for different scales of deployment, and where the network is deployed using existing physical infrastructure (alongside new build).

⁵ Wavelength Division Multiplexing.

Network coverage

- 2.13 Our proposed model offers the flexibility of estimating the costs of deploying a fibre network with national or subnational footprints (i.e. in particular geographic areas only).
- 2.14 We have used postcode sectors as the geographic unit for our cost modelling. We consider that this approach provides sufficient geographic granularity while, at the same time, avoids introducing too much complexity to our modelling. Although network operators may consider wider geographic areas when deploying a network, the use of postcode sectors is consistent with our proposed approach to defining geographic markets in our December 2018 Consultation.

Scorched node/Scorched earth approach

- 2.15 Given we are interested in understanding the costs of deploying a fibre network at different scales and footprints, we propose to build a bottom-up model that is capable of supporting both a scorched node and a scorched earth approach.
- Under the scorched node approach the fibre network is deployed assuming the location of existing Access Nodes. This has the advantage of being more grounded in reality; recognising that network operators are likely to place importance on the topology of their existing networks when deciding how to deploy a new fibre network.
 - Under a scorched earth approach the network is dimensioned so that the location of the Access Node minimises the costs of deployment. A scorched earth approach may be more appropriate when modelling the costs of deploying a fibre network for a new entrant which starts with a network of limited scale or has no network at all.

Reuse of existing physical infrastructure

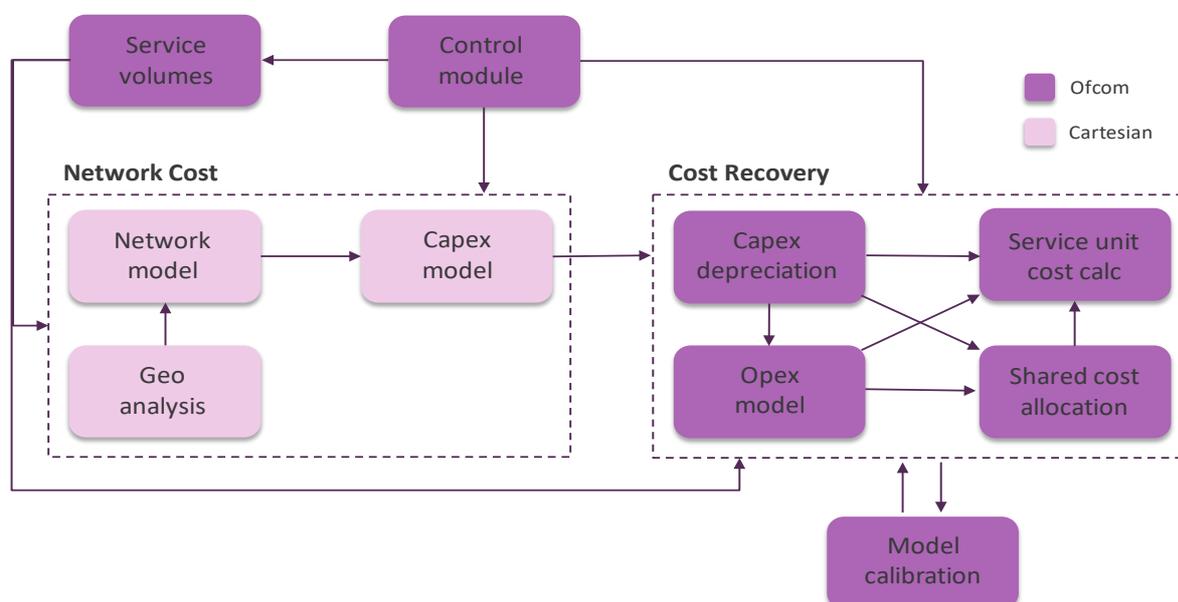
- 2.16 Physical infrastructure, such as ducts and poles, is a key input in the building of a fibre network.
- 2.17 An operator deploying a fibre network can either (i) reuse existing physical infrastructure; (ii) build new physical infrastructure; or (iii) a combination of both. Our model allows the functionality to estimate the costs of deploying a fibre network under any of these scenarios.
- 2.18 Notwithstanding this, we consider that an operator planning to build a fibre network would seek to reuse as much physical infrastructure as possible (given the higher costs of building new physical infrastructure).
- 2.19 Therefore, our base case assumption is to model a fibre network which reuses existing physical infrastructure where spare capacity is available and only builds new physical infrastructure where this is not available or feasible.
- 2.20 Where the modelled network reuses existing physical infrastructure, we propose to include the costs of renting the space used in the physical infrastructure as an operating cost at the level of Openreach's Physical Infrastructure Access (PIA) charges.

2.21 The model also allows for a network to supply DPA services. This means that the modelled network can reuse existing infrastructure to build the network and also offer this input to third party networks. An example of this is Openreach offering PIA services to other telecoms providers.

Model structure

2.22 The fibre network model comprises four modules, three of which have been developed by Ofcom ('Control', 'Service Volumes' and 'Cost Recovery'), with the other one ('Network Cost') being developed by Cartesian. The module structure for the model is shown in Figure 1 below.

Figure 1: Module structure of the fibre network model



Source: Ofcom

2.23 Each module is responsible for the following:

- Control – this consolidates the key assumptions that are used across all the other modules. It is used to calculate the final outputs under different scenarios and assess the sensitivity of our modelled assumptions.
- Service volumes – computes the speed of fibre deployment to end customers by geographic area (i.e. premises passed) and calculates the associated volumes of each relevant fibre service (e.g. number of rentals, connections and ancillary services) in each modelled year.
- Network Cost – combines the service volumes with network capacity and coverage parameters to dimension the fibre network. It then calculates the capital expenditure required to build and operate the dimensioned fibre network.

- Cost recovery – uses the outputs from the Network Cost module (along with the Volumes module) to calculate operating costs and determine how total costs are recovered across services over time.

2.24 We set out more information about the workings of each module below. Further details about the Network Cost module built by Cartesian can be found in the Cartesian report which accompanies this consultation document.

Possible approaches to model calibration / cost verification

2.25 Going forwards, it will be necessary to consider how best to calibrate and verify the costs in the model to check the reasonableness of the outputs. When we have built bottom-up models in the past, we have calibrated the outputs against actual real-world data wherever possible. For example:

- a) In the 2018 Wholesale Local Access (WLA) Charge Control, we calibrated our bottom-up model of an FTTC overlay network against asset count and cost information from multiple data sources, including BT's Chief Engineer's Model, BT's RFS and BT's Management Accounts.
- b) In the 2015 Mobile Call Termination (MCT) Charge Control modelling, we compared model outputs with mobile provider data to check that the model was producing realistic outputs. We compared the amount of network equipment and the total cost of that equipment (GBV, NBV and opex) against the average, maximum and minimum for these values from the mobile provider data. By comparing these values over time, we were more confident in the robustness of the cost volume relationships in the model.
- c) When building the 2013 Narrowband Charge Control model, we did not have data for a national NGN operator which we could use for calibration purposes. Instead, we calibrated the unit cost outputs against the unit cost of a fully depreciated TDM network and a hypothetical ongoing TDM network.

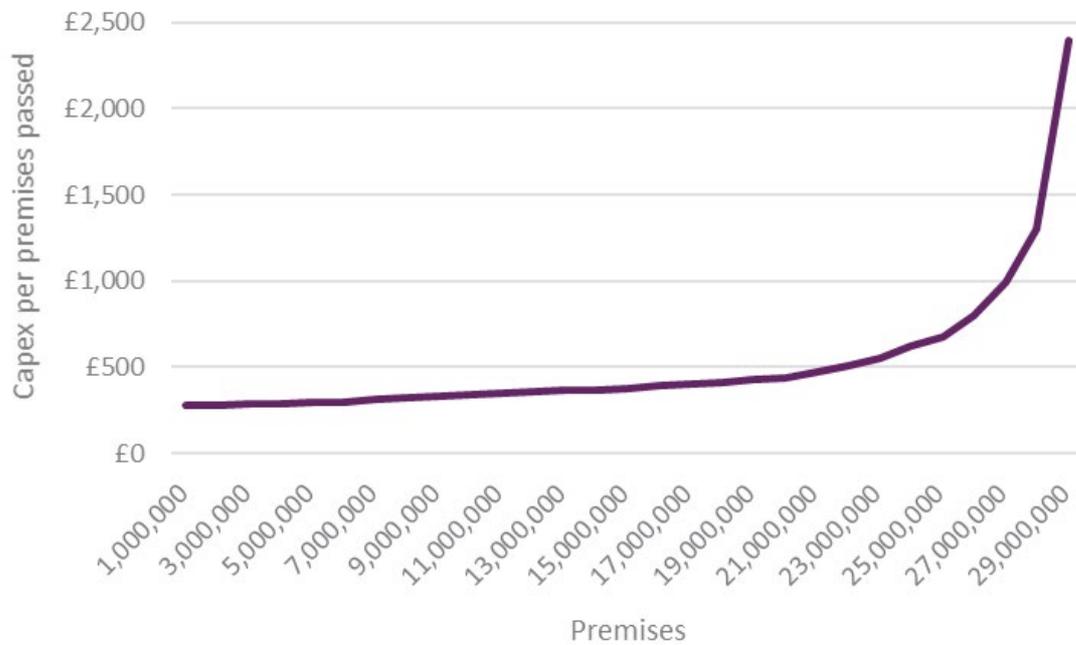
2.26 The availability and quality of data will ultimately inform our approach to calibration and cost verification.

2.27 However, where possible, we propose to compare the outputs of our fibre cost modelling work with actual and forecast operator data to ensure their reasonableness. For example, we might calibrate our model outputs in the following way:

- a) Against data provided by Openreach and other telecoms providers that are currently deploying large scale fibre networks (either on a national or sub-national basis). For example, we could sense check our modelling by comparing our model outputs against data on capex per home passed from telecom operators' business plans and network rollouts. By way of illustration, Figure 2 below provides outputs from the bottom-up model that we could be used to this end.
- b) Against other NRAs' fibre network models: Ofcom is not the only NRA modelling fibre network costs. We could, for example, check our model outputs against the outputs of other NRA models, or, where the modelling approaches are sufficiently similar, we

could look at other metrics such as total network costs and the quantity of network equipment.

Figure 2. Capex per premises passed for an FTTP deployment, sequenced from lowest to highest cost to reach [£ per premises passed]



Source: Ofcom, Cost Recovery module

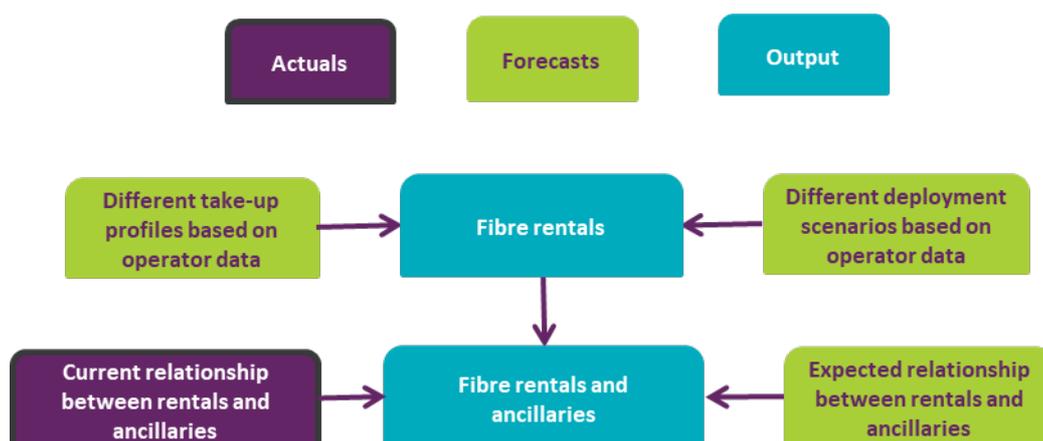
Question:

Question 1: Do you agree with our general approach to modelling?

3. Service volume forecasting

- 3.1 In this section we set out our broad approach to modelling fibre service volumes. This will allow stakeholders to comment on the proposed end-to-end approach to cost modelling a fibre network.
- 3.2 Below we set out our proposed approach to:
 - Creating different deployment scenarios;
 - Creating different take-up profiles;
 - Modelling the demand for passive services; and
 - Consolidating some services under a common label.
- 3.3 At this stage, we are not seeking views on the detail or specific figures currently in the Volumes module. These numbers should be regarded as placeholders only.
- 3.4 The structure of the Volumes module is illustrated in the following flowchart.

Figure 3: Structure of the Volumes module



Source: Ofcom

Deployment scenarios: FTTP and Leased Lines

- 3.5 Service volumes are a function of network deployment and take-up. In our approach to forecasting service volumes, we first make assumptions about the scale of network deployment, i.e. how many premises are reached in the long run, and the speed of network deployment, i.e. how many premises are built out to each year. This allows us to determine the coverage of the network in each year. We then apply a take-up profile to the modelled deployment to determine the number of connections.
- 3.6 We have taken a different approach to forecasting leased lines deployment, which is a function of the assumed FTTP deployment.

FTTP

- 3.7 We are interested in understanding the costs of deploying a fibre network by both an incumbent operator and by an entrant operator since we expect deployment may vary by type of operator (and by geographic market).⁶ Therefore, the model has the functionality to include up to ten different deployment scenarios, which can be used to model different scales (and speeds) of network deployment. The Control module is used to select the desired scenario, but the list of scenarios is found in the Volumes module.
- 3.8 We have created several different deployment scenarios for each geographic area, which assume different levels of network coverage and speed of deployment. These scenarios are based on publicly available information on FTTP deployment. However, these should only be viewed as placeholders that have been chosen to test the functionality of the model. We expect the final version of the model to use scenarios that are directly derived from business plans and evidence provided by operators.
- 3.9 We have included checks in the model to ensure that FTTP deployment in a geographic area does not exceed the maximum number of premises in an area. The cap is determined by the maximum number of premises calculated as part of our geospatial analysis, ensuring consistency across the different modules.
- 3.10 Finally, the model has the capability to exclude premises that are state funded.⁷ We have assumed that the premises receiving state funding for FTTP deployment will be in the postcode sectors with the highest cost per premises in Geographic Area 3.⁸ As a placeholder, we have chosen to exclude three million premises which is consistent with the “final c. 10%” in the 2018 Future Telecoms Infrastructure Review.⁹

Leased Lines

- 3.11 We consider that new large-scale fibre networks will provide all fibre services, including leased lines. Our model has the capability of estimating the costs of deploying leased line services as an addition to an FTTP deployment (i.e. as part of a multi-service network).
- 3.12 We propose to model leased lines deployment as a proportion of total fibre deployment, where the proportion can vary by geographic area. Our model includes placeholder values for these proportions that are based on the mix of residential broadband and leased lines volumes across all operators.

⁶ We consider it likely that an incumbent operator can roll-out faster and achieve greater coverage than an entrant operator. In part, this is due to its ability to utilise existing duct infrastructure in a more effective manner than an entrant.

⁷ The model does not include any allowance for government subsidies, thus the actual cost faced by an operator to deploy to these premises will be overstated. Furthermore, it is likely that deployment to these areas will utilise other technologies, e.g. FWA, given the high cost of deploying FTTP. The switch in the model allows us to observe the cost of deploying FTTP to these areas but with the option to remove them from our cost estimates.

⁸ The Volumes module determines the coverage assumed in the Network Cost module which assumes that deployment first occurs in the postcode sectors with the lowest cost per premises.

⁹ DCMS, Future Telecoms Infrastructure Review, July 2018

<https://www.gov.uk/government/publications/future-telecoms-infrastructure-review>

Take-up profiles: FTTP and Leased Lines

FTTP

- 3.13 The model can include up to six different take-up profiles which should be consistent with the six deployment scenarios. These take-up profiles determine the number of customers, for a given deployment, that are purchasing a FTTP service on the modelled network.
- 3.14 Based on telecoms providers' business plans that we have reviewed, we consider it appropriate to assume that the long-run take-up is reached within ten years for a given deployment.¹⁰ We expect take-up to vary by geographic area, for example due to the differing levels of network competition.

Leased Lines

- 3.15 We recognise that the market conditions are different for leased lines and FTTP, so we expect to use different take-up profiles for leased lines compared to FTTP.
- 3.16 The model uses the same take-up assumption for all leased line products (within a given geographic area), i.e. the take-up assumption is used to determine total demand for business connectivity. Once this total demand is determined, we propose modelling the breakdown of leased lines by:
- Bandwidth – ethernet electronic costs may vary depending on the bandwidth required. Therefore, we propose to model the proportion of leased lines that require 100Mbit/s, 1Gbit/s, and 10Gbit/s bandwidths. For optical services, we do not propose to model the breakdown by bandwidth given that the network model assumes the same wavelength card for all optical services.¹¹
 - Circuit type – given that costs vary by circuit length, we propose to model the proportion of leased lines that are local access (LA), inter-exchange, and non-LA circuits with two access tails.¹²
 - Passive vs. active – we also propose to model the proportion of leased lines that the modelled network supplies as passive services, i.e. DPA and dark fibre. These volumes are set out in greater detail below.

DPA and Dark Fibre volumes

- 3.17 We propose to model passive service volumes (i.e. duct and pole access; and dark fibre) as the network operator will face different costs for providing these services compared to equivalent active services. Namely, the network operator does not need to provide fibre cabling for DPA services, or terminal equipment for dark fibre services.

¹⁰ In other words, if the network deploys to one million homes in Year 1 then the proportion of those homes that purchase a service will not change after Year 10. We note that take-up can be modelled to stabilise sooner, e.g. by Year 5.

¹¹ From a cost modelling perspective, this means that the bandwidth mix for optical services is not important.

¹² We expect the proportion of non-LA circuits with only one access tail to be small so do not propose to model these as we think it would add a disproportionate amount of complexity.

3.18 We are proposing to model a hypothetical operator that is deploying fibre services from scratch, i.e. there are no existing fibre services in Year 0. Accordingly, the passive service volume assumptions in the model represent the long-term mix of demand for active and passive services (and therefore do not include assumptions relating to the cannibalisation of active volumes). Furthermore, the passive service volumes do not include any self-consumption of DPA by the network provider, so they are distinct from the network re-use assumptions described in Sections 2 and 4.

DPA volumes

3.19 We propose to model DPA volumes as the number of end customers that are served using DPA services provided by the modelled network. The Network Cost module then converts these volumes into the required network elements such as duct space and lengths. We propose using the same DPA usage assumptions for FTTP and leased lines, i.e. the same proportion of fibre services is provided via DPA for both residential and business broadband.

3.20 As a modelling simplification, we assume that DPA is not used for inter-exchange circuits. We do not expect this assumption to have a material impact on costs.

3.21 We propose modelling DPA volumes for each segment of the access network separately.¹³ This is because telecoms providers may connect to the access network at any point between the exchange and customer premises.

Dark fibre volumes

3.22 To assess the impact of dark fibre provision on network costs, dark fibre can be modelled under the following scenarios: (i) Dark fibre is provided across all parts of the modelled network, e.g. for the entrant; (ii) Dark fibre is restricted to inter-exchange connectivity only; (iii) Dark fibre is not provided at all. The model also provides the flexibility to vary the proportion of dark fibre services for each of Geographic Areas 1, 2 and 3.

Relationship between rentals and ancillary services

3.23 In our model, ancillary services refer to connections, migrations (across products as well as providers), Cablelink¹⁴, and Main link¹⁵. We propose to model volumes for these services based on the relationship between rentals and ancillaries using information provided by operators, both actuals and forecasts.

3.24 Therefore, service volumes for ancillaries are directly related to the number of rentals. However, we note that the relationship between rentals and a given ancillary can vary over time, so volume trends may still differ to some extent.

¹³ In the Network Cost module, segments of the network are defined as follows: - Segment 1: the network between the Exchange (or Fibre Node) and the Splitter Node; Segment 2: the network between the splitter node and the Distribution Point; and Segment 3: the network between the Distribution Point and the customer premises.

¹⁴ Cablelink is a tie-cable service that allows a telecoms provider to connect its network at a BT exchange.

¹⁵ Main link is a circuit that provides a connection between two BT exchanges.

Consolidation of services

3.25 To simplify the cost model, we propose to consolidate some of the ancillary services when producing final outputs. This is because these services often face similar costs or require similar activities. We illustrate this consolidation in the table below:

Table 1: Consolidation of ancillary services

FTTP software change Comprising of:	Leased lines equipment replacement Comprising of:
FTTP Start of Stopped Line	Leased line Start of Stopped Line
FTTP Bandwidth Changes	Leased line Bandwidth / Product Changes
FTTP CP to CP migration (on the same network)	Leased line CP to CP migration (on the same network)
FTTP Ceases	

Question:

Question 2: Do you agree with our approach to forecasting service volumes?

4. Network dimensioning and costing

- 4.1 As set out in Section 3, we are proposing to use a bottom-up approach to model the costs of a fibre network.
- 4.2 We have commissioned Cartesian to build the model module that (i) dimensions the size of the fibre network (based on our service volume forecasts and network rollout assumptions - see Section 3; and (ii) estimates the capex for the dimensioned network. Ofcom has built the model module which determines the operating costs of the modelled network.
- 4.3 In this section we set out our proposed high-level approach to dimensioning and costing the fibre network. Further details of our approach are set out in the Cartesian Report published alongside this consultation document.
- 4.4 The remainder of this section is structured as follows:
 - a) Our approach to dimensioning the fibre network; and
 - b) Our approach to costing the network.

Network dimensioning

- 4.5 Once the network footprint and service demand has been established, we need to dimension the network capable of supporting the selected coverage and demand.
- 4.6 The model takes a different approach for dimensioning the network for FTTP services and leased lines (including dark fibre). For FTTP, the size of the network is determined by coverage first and then by capacity. For leased lines, this is determined by capacity alone. The underlying assumption is that the network is deployed to reach FTTP customers first and, as demand for FTTP and leased lines grows over time, additional network elements are added to support this.

FTTP

- 4.7 To dimension the network to meet the demand for FTTP services, the model firstly ranks postcode sectors according to the cost of deployment (from lowest cost to highest cost relating to the average cost per premises passed). Then, based on the total number of premises assumed to be passed in each year, the model identifies the postcode sectors to be deployed over the modelling period (deploying in sequence from the lowest cost to highest cost postcode sectors using the ranking described).
- 4.8 The model then calculates the number of metres of fibre cable, access nodes and aggregation nodes required by postcode sector based on a detailed geospatial analysis. The outputs of this analysis provide estimates of the number of network elements needed to pass all premises within each postcode sector.

- 4.9 In some cases, network elements can span across multiple postcode sectors. For example, to connect a premises to an Access Node, a network operator may need to deploy duct and fibre across more than one postcode sector.
- 4.10 The model has been developed to provide the functionality to estimate the costs of multiple coverage scenarios ranging from national level to sub-national level (at its most granular at postcode sector level). However, given this flexibility, there is a risk that as the modelled coverage expands, network elements that span across postcodes could be counted more than once.
- 4.11 To deal with this issue, the model dimensions the network across the whole of UK first and then apportion the network infrastructure elements to each postcode sector based on infrastructure length. Although this reduces the accuracy of our cost estimates at a subnational level it avoids the risk of double counting. We consider that any inaccuracy this approach may cause is likely to be small when considering broad geographic areas.

Leased Lines

- 4.12 The model then works out the additional network elements required to meet the demand for leased line services (including dark fibre), which are over and above those required to serve FTTP customers.
- 4.13 To this end, the model assumes that leased lines are provided over fibre cables which are separate to those carrying FTTP services. Therefore, demand for leased lines always drives additional fibre cables in the model. The model, however, does assume that certain assets are shared across FTTP and business connectivity services, such as duct, poles, splitter nodes and access nodes (excluding electronics).
- 4.14 In contrast to FTTP, the network elements which are driven by the supply of business connectivity services are assumed to be installed as and when take-up occurs. This differs to FTTP services for which network elements are mainly driven by coverage, and not capacity.

DPA services

- 4.15 DPA services provide capacity in the network's physical infrastructure for other telecoms providers to deploy their own fibre cables. The network elements required for the provision of DPA services are mainly ducts and poles.
- 4.16 To dimension the network elements required for these services, the model works out how much space in duct and poles is needed to meet the demand for DPA services by postcode sector. The volume of network elements is calculated by considering the number of end-users to be served by access seekers consuming DPA services; and converting this to the number of fibre cables required in each postcode sector. Therefore, network elements are driven by both coverage and capacity for these services.

Determining the amount of new physical infrastructure

- 4.17 Once the amount of fibre cable length (needed to meet the total service demand forecast) is derived, the model then calculates the amount of physical infrastructure required to carry these fibre cabling.
- 4.18 The model allows for this physical infrastructure to be new or existing. To work out the proportion of infrastructure that will be new, the model compares the amount of physical infrastructure required against the assumed capacity available in existing infrastructure, by postcode sector.
- a) If enough capacity is available, the model assumes no new physical infrastructure is required.
 - b) If not enough capacity is available, the model assumes new physical infrastructure is needed but only for the portion which cannot reuse existing infrastructure.
 - c) If no capacity is available at all, the model assumes no reuse of existing physical infrastructure.

Network costing

Capex

- 4.19 Once the network is dimensioned, we then calculate the capex and opex required for building that network.
- 4.20 Network capex is calculated in the Network Cost model. Details of the approach taken are set out in the Cartesian Report published alongside this consultation document.

Opex

Relevant opex in a fibre network

- 4.21 At a high level, the key opex in a fibre network are:
- **Repair costs** – costs of repairing network faults arising at both the passive and active layers of the network;
 - **Maintenance costs** – costs associated with maintenance activities across the network, including those associated with the monitoring of network performance;
 - **Power and accommodation** – costs in relation to the power and physical space taken by the equipment located at the network node/exchange;
 - **General Management** – corporate overheads such as management, finance and legal costs;
 - **Systems and per order processing costs** – costs associated with processing and recording new orders;
 - **Customer installation costs** – labour costs associated with connecting a new customer such as engineer visits to customer premises; and

- **Service Level Guarantee (SLG) costs** – costs faced by the network provider when it fails its service level guarantees.

Our proposed approach to modelling opex

- 4.22 We propose to model the relevant operational costs as follows:
- a) For repair, maintenance, power, accommodation, systems and general management (which tend to be shared across multiple services) we propose to adopt a simplified approach whereby we model these costs as a proportion of the Gross Replacement Cost of the underlying network assets.
 - b) For SLG, processing and customer installation costs, which are typically incremental to individual services, we propose to model them bottom-up and use individual service volumes as the driver of these costs.
- 4.23 Regarding the first group of costs (i.e. shared opex), our initial view is that a simplified approach is appropriate since we anticipate that these will comprise mainly of general management costs but based on our experience from the 2018 WLA cost modelling do not anticipate that robust bottom-up general management cost data will be available. Therefore, our current view, is that there would be little to gain from taking a more granular approach in modelling the residual shared operational costs. Second, our 2018 WLA model outputs indicate that shared operational costs as a proportion of total cumulative capex tends to be quite stable over time¹⁶, so a simplified approach which estimates these costs based on modelled cumulative capex appears reasonable and proportionate in this case.
- 4.24 We consider that for order processing and customer installation costs the main driver is new connections, while for SLG costs there are two main drivers, connections and rentals. Therefore, we propose to use these drivers to model these costs and use bottom-up cost evidence to inform the per unit connection/rental cost.

Question:

Question 3: Do you agree with our approach to network dimensioning and costing?

¹⁶ This proportion was of around 9% in our WLA bottom-up model. We expect this proportion to be lower for a fibre network deployment.

5. Cost recovery

5.1 In this section we explain how the model recovers network costs across time and across services.

Depreciation approaches

5.2 The fibre network model has the functionality to recover costs over time using the following depreciation approaches:

- a) Economic Depreciation (ED);
 - i) Original Economic Depreciation (Original ED);
 - ii) Simplified Economic Depreciation (Simplified ED); and
- b) Current Cost Accounting (CCA).

5.3 We briefly discuss each depreciation approach below.

Economic Depreciation

5.4 The economic depreciation (ED) method matches the cost of equipment to the actual and forecast use over the long term. Consequently, there is relatively little depreciation in years when utilisation is low and relatively high depreciation in years of full, or almost full, equipment utilisation.

5.5 Economic depreciation can come in a number of forms. In our model we have included two forms of ED, Original ED and Simplified ED.

5.6 Original ED seeks to set the optimal path of cost recovery over time by mimicking the outcomes of a benchmark competitive market. Under this approach, unit prices in a given year do not depend on the level of utilisation at that point in time, but on the level of utilisation achieved over the lifetime of the network.

5.7 This approach to economic depreciation has been used by Ofcom in previous bottom-up cost models, for example the 2013 Narrowband Charge Control, 2015 MCT Charge Control and 2018 MCT Charge Control.

5.8 An alternative form of economic depreciation is "Simplified ED", which is intended to retain many of the characteristics of Original ED, but uses a simpler functional form. In this approach, the shape of the path of unit cost recovery remains independent of the level of in-year utilisation and is therefore determined by changes in input costs alone, as in the Original ED methodology. However, the entire profile of cost recovery for an asset is given a shape which exactly mimics the profile of input cost trends, scaled so as to achieve full cost recovery.

Current Cost Accounting

- 5.9 The CCA approach results in the same level of total cost recovery (over the life of the model) as an ED approach, however the chief difference lies in the path of cost recovery over time. The key characteristics of the timing of cost recovery under an accounting depreciation approach is as follows:
- Capital costs are recovered as the sum of depreciation and the cost of capital employed. Depreciation is calculated for each asset as the gross book value of that asset divided by its lifetime, whilst the cost of capital employed is calculated as the cost of capital multiplied by the net book value of the network operator's total asset base.
 - Straight-line depreciation means that depreciation is not deferred from years when utilisation is lower to those when it is higher, as under an economic depreciation approach. Consequently, unit capital costs tend to be inversely related to utilisation.
 - Operating costs are recovered in the year in which they are incurred, meaning that, once a network component is purchased, unit operating costs are also inversely related to utilisation (i.e. unit operating costs decrease as utilisation increases).

Summary

- 5.10 We will consult on our preferred approach to depreciation as part of our Fixed Telecoms Market Review proposals document in December 2019.

Assessment duration

- 5.11 In regard to the duration of the assessment, we have sought to base the model on the long run relationships between service volumes and component volumes (and associated costs). We consider that a 40 year horizon is sufficient to capture long run relationships, given the asset lives involved. Costs beyond the 40 year horizon are captured using a perpetuity calculation. We note that we have modelled a 40 year duration in other recent Ofcom bottom up cost models, including the 2013 and 2017 NCC models; and 2015 and 2018 MCT models. Using a long assessment duration also gives us the option to use economic depreciation should we wish to calculate service unit costs under that depreciation approach.
- 5.12 Given the difficulty in constructing robust forecasts over long periods, we propose to take an approach (as we have in other models) of assuming a steady state forecast after a certain point. We therefore propose to explicitly model (for example for volumes and costs) out to 2056/57, which is 40 years from the start of the assessment in 2017/18.

Cost of Capital

- 5.13 The model currently uses a placeholder value for the weighted average cost of capital (WACC).

- 5.14 We will consult on the proposed WACC as part of our Fixed Telecoms Market Review proposals document in December 2019.

Shared costs

- 5.15 Given that a fibre network can support multiple services, there are a number of costs which are likely to be shared by more than one service.
- 5.16 We distinguish between two types:
- a) **Cross service group shared costs:** costs which are shared by services belonging to two or more service groups (e.g. FTTP and Leased lines). An example of such costs is duct; and
 - b) **Intra service group shared costs:** costs which are shared by services belonging to the same service group (e.g. FTTP). Examples of these costs include fibre cable and equipment costs.
- 5.17 The fibre network cost model provides the functionality to allocate shared costs in the following ways:
- a) **Equi-Proportional Mark-Up (EPMU):** This method allocates shared costs on the basis of costs. Under this method, shared costs are allocated to services in the same proportion as the LRIC of each individual service. Therefore, the higher the LRIC of supplying a particular service, relative to other services, the higher the cost mark-up for that service.
 - b) **Volume-based allocation:** This method allocates shared costs on the basis of service volumes. For example, if service volumes refer to active lines, then a higher proportion of shared costs would be allocated to services with the largest number of active lines. This means that, under this method, each line would make the same contribution to the recovery of shared costs, irrespective of the service provided, and therefore would have the same mark-up.
 - c) **Value-based allocation:** This method allocates shared costs on the basis of current prices. This means that the higher the price of a service, the larger the proportion of shared costs allocated to that service. Under this method, the mark-up would be higher for services with a higher price point.
- 5.18 Furthermore, the fibre network cost model allows these three methods to be used to allocate shared costs within the following service groups:
- Cross DPA, FTTP and leased lines
 - Cross DPA and FTTP
 - Cross FTTP and leased lines
 - Cross DPA and leased lines
 - Intra DPA
 - Intra FTTP
 - Intra leased lines

Service Costing

- 5.19 Once we have determined how the costs of a particular network element should be recovered over time, we need to calculate how they will be recovered from different network services.
- 5.20 The costs recovered by a particular service are linked to the costs that are driven by that network service. Each network service has a routing factor relating to each piece of network equipment (i.e. network element), which will drive the amount of network equipment needed to carry a unit of the service. This will determine the unit long-run incremental cost (LRIC) of that service. Shared costs are then added on top to generate unit LRIC+ estimates for each service.
- 5.21 The model provides the flexibility to allocate shared costs to the whole range of services or to a sub-set of services carried over the modelled network.

Question:

Question 4: Do you agree with our approach to cost recovery?

A1. Responding to this consultation

How to respond

- A1.1 Ofcom would like to receive views and comments on the issues raised in this document, by 5pm on 2 August 2019.
- A1.2 You can download a response form from <https://www.ofcom.org.uk/consultations-and-statements/category-2/investment-competition-fibre-networks-approach-model>. You can return this by email or post to the address provided in the response form.
- A1.3 If your response is a large file, or has supporting charts, tables or other data, please email it to approach.tomodel@ofcom.org.uk, as an attachment in Microsoft Word format, together with the cover sheet (<https://www.ofcom.org.uk/consultations-and-statements/consultation-response-coversheet>). This email address is for this consultation only, and will not be valid after 2 August 2019.
- A1.4 Responses may alternatively be posted to the address below, marked with the title of the consultation:
- Competition Group
Ofcom
Riverside House
2A Southwark Bridge Road
London SE1 9HA
- A1.5 We welcome responses in formats other than print, for example an audio recording or a British Sign Language video. To respond in BSL:
- Send us a recording of you signing your response. This should be no longer than 5 minutes. Suitable file formats are DVDs, wmv or QuickTime files. Or
 - Upload a video of you signing your response directly to YouTube (or another hosting site) and send us the link.
- A1.6 We will publish a transcript of any audio or video responses we receive (unless your response is confidential)
- A1.7 We do not need a paper copy of your response as well as an electronic version. We will acknowledge receipt if your response is submitted via the online web form, but not otherwise.
- A1.8 You do not have to answer all the questions in the consultation if you do not have a view; a short response on just one point is fine. We also welcome joint responses.
- A1.9 It would be helpful if your response could include direct answers to the questions asked in the consultation document. The questions are listed at Annex 4. It would also help if you could explain why you hold your views, and what you think the effect of Ofcom's proposals would be.

- A1.10 If you want to discuss the issues and questions raised in this consultation, please contact James Francey on 020 7783 4363, or by email to james.francey@ofcom.org.uk.

Confidentiality

- A1.11 Consultations are more effective if we publish the responses before the consultation period closes. In particular, this can help people and organisations with limited resources or familiarity with the issues to respond in a more informed way. So, in the interests of transparency and good regulatory practice, and because we believe it is important that everyone who is interested in an issue can see other respondents' views, we usually publish all responses on our website, www.ofcom.org.uk, as soon as we receive them.
- A1.12 If you think your response should be kept confidential, please specify which part(s) this applies to, and explain why. Please send any confidential sections as a separate annex. If you want your name, address, other contact details or job title to remain confidential, please provide them only in the cover sheet, so that we don't have to edit your response.
- A1.13 If someone asks us to keep part or all of a response confidential, we will treat this request seriously and try to respect it. But sometimes we will need to publish all responses, including those that are marked as confidential, in order to meet legal obligations.
- A1.14 Please also note that copyright and all other intellectual property in responses will be assumed to be licensed to Ofcom to use. Ofcom's intellectual property rights are explained further at <https://www.ofcom.org.uk/about-ofcom/website/terms-of-use>.

Next steps

- A1.15 Following this consultation period, Ofcom plans to set out full details of our regulatory proposals in the fixed telecoms market, alongside our market analysis and SMP findings, in December 2019.
- A1.16 If you wish, you can register to receive mail updates alerting you to new Ofcom publications; for more details please see <https://www.ofcom.org.uk/about-ofcom/latest/email-updates>

Ofcom's consultation processes

- A1.17 Ofcom aims to make responding to a consultation as easy as possible. For more information, please see our consultation principles in Annex 2.
- A1.18 If you have any comments or suggestions on how we manage our consultations, please email us at consult@ofcom.org.uk. We particularly welcome ideas on how Ofcom could more effectively seek the views of groups or individuals, such as small businesses and residential consumers, who are less likely to give their opinions through a formal consultation.
- A1.19 If you would like to discuss these issues, or Ofcom's consultation processes more generally, please contact the corporation secretary:

Corporation Secretary
Ofcom
Riverside House
2a Southwark Bridge Road
London SE1 9HA
Email: corporationsecretary@ofcom.org.uk

A2. Ofcom's consultation principles

Ofcom has seven principles that it follows for every public written consultation:

Before the consultation

- A2.1 Wherever possible, we will hold informal talks with people and organisations before announcing a big consultation, to find out whether we are thinking along the right lines. If we do not have enough time to do this, we will hold an open meeting to explain our proposals, shortly after announcing the consultation.

During the consultation

- A2.2 We will be clear about whom we are consulting, why, on what questions and for how long.
- A2.3 We will make the consultation document as short and simple as possible, with a summary of no more than two pages. We will try to make it as easy as possible for people to give us a written response. If the consultation is complicated, we may provide a short Plain English / Cymraeg Clir guide, to help smaller organisations or individuals who would not otherwise be able to spare the time to share their views.
- A2.4 We will consult for up to ten weeks, depending on the potential impact of our proposals.
- A2.5 A person within Ofcom will be in charge of making sure we follow our own guidelines and aim to reach the largest possible number of people and organisations who may be interested in the outcome of our decisions. Ofcom's Consultation Champion is the main person to contact if you have views on the way we run our consultations.
- A2.6 If we are not able to follow any of these seven principles, we will explain why.

After the consultation

- A2.7 We think it is important that everyone who is interested in an issue can see other people's views, so we usually publish all the responses on our website as soon as we receive them. After the consultation we will make our decisions and publish a statement explaining what we are going to do, and why, showing how respondents' views helped to shape these decisions.

A3. Consultation coversheet

BASIC DETAILS

Consultation title:

To (Ofcom contact):

Name of respondent:

Representing (self or organisation/s):

Address (if not received by email):

CONFIDENTIALITY

Please tick below what part of your response you consider is confidential, giving your reasons why

Nothing

Name/contact details/job title

Whole response

Organisation

Part of the response

If there is no separate annex, which parts? _____

If you want part of your response, your name or your organisation not to be published, can Ofcom still publish a reference to the contents of your response (including, for any confidential parts, a general summary that does not disclose the specific information or enable you to be identified)?

DECLARATION

I confirm that the correspondence supplied with this cover sheet is a formal consultation response that Ofcom can publish. However, in supplying this response, I understand that Ofcom may need to publish all responses, including those which are marked as confidential, in order to meet legal obligations. If I have sent my response by email, Ofcom can disregard any standard e-mail text about not disclosing email contents and attachments.

Ofcom seeks to publish responses on receipt. If your response is non-confidential (in whole or in part), and you would prefer us to publish your response only once the consultation has ended, please tick here.

Name

Signed (if hard copy)

A4. Consultation questions

Question 1: Do you agree with our general approach to modelling?

Question 2: Do you agree with our approach to forecasting service volumes?

Question 3: Do you agree with our approach to network dimensioning and costing?

Question 4: Do you agree with our approach to cost recovery?