Narrowband Market Review: Statement

Annexes 1-8

Redacted [✂] for publication

STATEMENT:

Published: 30 November 2017

Contents

Annex

A1. Sources of evidence

A1.1 We have noted throughout this statement the evidence we have relied upon in relation to our findings and how we have relied upon that evidence. This Annex lists the main sources of evidence used, including all responses to our consultations and to our formal information requests.

A1.2 While this Annex lists the main evidence we have relied upon, the list is for convenience only and is not intended to be exhaustive.

Responses to the April 2015 call for inputs

A1.3 On 2 April 2015 we published a call for inputs (April 2015 CFI) on our review of the WCO and WCT markets. We sought views on the scope of the review, relevant developments since the last review that may affect market definition and SMP analysis, and the effectiveness and appropriateness of existing remedies in these two markets, including regulation of interconnect circuits.[1]

A1.4 12 stakeholders provided written responses to the April 2015 CFI:

- BT Group
- Colt Technology Services (Colt)
- EE Limited (EE)
- Federation of Communication Services
- KCOM Group plc (KCOM)
- Post Office
- Sky UK Limited (Sky)
- Telecom2 Ltd (Telecom2)
- Verizon Enterprise Solutions (Verizon)
- Virgin Media plc (Virgin Media)
- Vodafone Group plc (Vodafone)
- [✂]

A1.5 We have published non-confidential versions of the responses from the stakeholders listed above. These can be found on our website.[2]

Responses to the 2016 NMR Consultation

A1.6 On 1 December 2016, we published our main NMR consultation (2016 NMR Consultation), to gather stakeholders' views on the work we had undertaken in assessing the state of

[1] Ofcom, 2015. *Review of fixed call origination and fixed termination markets 2016-19 Call for Inputs.* https://www.ofcom.org.uk/__data/assets/pdf_file/0028/84592/review-fixed-call-termination2016-19.pdf.
[2] https://www.ofcom.org.uk/consultations-and-statements/category-2/review-fixed-call-origination-termination-markets.

competition in the narrowband markets in the UK and our proposals for regulating these markets in the next NMR review period.

A1.7 18 stakeholders provided written responses to the consultation:

- An individual[3]
- BT Group
- Colt
- KCOM
- Magrathea Telecommunications Limited (Magrathea)
- Openreach
- Sky
- SSE
- TalkTalk Telecom Group plc (TalkTalk)
- Three UK (Three)
- Kantar TNS
- Verizon
- Vodafone
- [✂]
- [✂]

A1.8 We have published non-confidential versions of the responses from the stakeholders listed above. These can be found on our website.[4]

Responses to the July 2017 NMR Further Consultation

A1.9 On 6 July 2017, we published a further NMR consultation on revised price notification requirements for all telecoms providers that offer WCT. In addition, we clarified how our proposals for the regulation of BT's interconnection circuits may apply to interconnection using next generation voice networks (which rely on internet protocol (IP) technology).

A1.10 Eight stakeholders provided written responses to the consultation:

- BT Group
- Magrathea
- Verizon
- Vodafone
- Telecom2
- TalkTalk [alongside one supplement]
- UK Competitive Telecommunications Association (UKCTA)
- [✂]

A1.11 We have published non-confidential versions of the responses from the stakeholders listed above. These can be found on our website.[5]

[3] [✂]
[4] https://www.ofcom.org.uk/consultations-and-statements/category-1/narrowband-market-review.
[5] www.ofcom.org.uk/consultations-and-statements/category-3/further-consultation-narrowband-market-review.

Responses to the August 2017 NMR Further Consultation

A1.12 On 22 August 2017, we published another further NMR consultation on a revised list of providers of WCT services that we propose have SMP in WCT. In addition, we proposed to include an additional ISDN30 service (Direct Dial Inward Planning Service) in the proposed ISDN30 charge control.

A1.13 Three stakeholders provided written responses to the consultation:

- BT Group
- Openreach
- [✂]

A1.14 We have published non-confidential versions of the responses from the stakeholders listed above. These can be found on our website.[6]

Information gathering using statutory powers (s.135)

A1.15 During this market review, we have issued a series of notices under s.135 of the CA03 requiring various telecoms providers to provide specified information as set out in the notice. These information requests are set out in the notice.

A1.16 Notice of 11 May 2015 regarding wholesale call origination. Request addressed to and response received from:

- BT Group – response received in five tranches on 26 May, 2 June, 3 October 11 November 2015 and 1 August 2017.
- Colt – response received in three tranches on 8 June, 10 June and 15 June 2015.
- EE – response received in two tranches on 29 May and 12 August 2015.
- Gamma – response received on 29 May 2015.
- KCOM – response received 26 May 2015.
- Post Office – response received 11 June 2015.
- Sky – response received in two tranches on 28 May and 8 June 2015.
- TalkTalk – response received in two tranches on 8 June and 11 June 2015.
- Verizon – response received in two tranches on 29 May and 1 July 2015.
- Virgin Media – response received in four tranches on 3 June, 8 June, 9 June and 19 June 2015.
- Vodafone – response received in two tranches on 29 May and 5 June 2015.
- MS3 – response received in two tranches on 29 May and 4 June 2015.

A1.17 Notice of 26 June 2015 regarding wholesale call termination, interconnect and charge control data. Request addressed to and received from:

- BT Group – response received in five tranches on 7 August, 13 August, 14 August, 14 September and 29 September 2015.
- Verizon – response received on 6 August 2015.

[6] https://www.ofcom.org.uk/consultations-and-statements/category-3/wct-providers-isdn30

A1.18 Notice of 10 July 2015 regarding interconnect data. Request sent to and received from:

- H3G – response received in two tranches on 13 August and 1 October 2015.
- O2 – response received on 13 August 2015.

A1.19 Notice of 10 July 2015 regarding wholesale call termination and interconnect data. Request addressed to and response received from:

- Colt – response received on 9 August 2015.
- Gamma – response received on 7 August 2015 alongside one supplement.
- KCOM – response received on 7 August 2015 alongside one supplement.
- Sky – response received in two tranches on 11 August and 14 August 2015.
- TalkTalk – response received in four tranches on 7 August, 12 August, 20 August and 9 September 2015.
- Virgin Media – response received in three tranches on 7 August, 13 August and 21 August 2015.
- Vodafone – response received in five tranches on 3 August, 28 August, 11 September, 29 September and 11 October 2015.

A1.20 Notice of 21 July 2015 regarding the ability to identify customer types. Request addressed to and response received from:

- BT Group – response received in two tranches on 30 July and 11 August 2015.

A1.21 Notice of 17 August 2015 regarding ISDN data. Request sent to and response received from:

- BT Group – response received in five tranches on 14 September, 23 September, 2 October, 10 November and 16 November 2015.
- Colt – response received on 14 September 2015.
- EE – response received on 15 September 2015.
- Gamma – response received on 9 September 2015.
- KCOM – response received on 7 November 2015.
- TalkTalk – response received on 14 September 2015.
- Virgin Media – response received on 25 September 2015.
- Vodafone – response received on 14 September 2015.

A1.22 Notice of 27 August 2015 regarding call detail records. Request sent to and response received from:

- BT Group – response received on 7 September 2015.

A1.23 Notice of 20 October 2015 regarding incremental administrative costs. Request sent to and response received from:

- BT Group – response received on 17 November 2015.

A1.24 Notice of 9 November 2015 regarding interconnect circuit costs. Request sent to and response received from:

- BT Group – response received on 23 November 2015.

A1.25 Notice of 6 January 2016 regarding DLE tandem volumes. Request sent to and response received from:

- BT Group – Response received on 29 November 2015.

A1.26 Notice of 4 March 2016 regarding volumes of OTT calls. Request sent to and response received from:

- Apple – response received on 18 March 2016
- Facebook – response received on 22 March 2016
- Google, Inc. – response received on 11 March 2016.
- WhatsApp, Inc. – response received on 10 March 2016.
- Skype – response received on 18 March 2016.
- Viber – response received on 17 March 2016.
- Vonage – response received on 18 March 2016.

A1.27 Notice of 10 June 2016 regarding retail market competition. Request sent to and response received from:

- BT (Consumer) – Response received in two tranches on 4 June and 24 June 2016.

A1.28 Notice of 29 June 2016 regarding single order GEA. Request sent to and response received from:

- BT Group – response received in two tranches on 14 and 18 July 2016.

A1.29 Notice of 11 July 2016 regarding wholesale call termination, ISDN and wholesale call termination data. Request sent to and response received from:

- BT Group – response received in five tranches on 25 July, 1 August, 2 August, 22 August and 31 August 2016.

A1.30 Notice of 1 July 2016 regarding wholesale call origination. Request sent to and response received from:

- EE – response received on 8 August 2016.
- Gamma – response received on 28 July 2016.
- Sky – response received in two tranches on 15 July and 18 July 2016.
- TalkTalk – response received in two tranches on 9 August and 31 August 2016.
- Verizon – response received on 27 July 2016.
- Virgin Media – response received on 13 July 2016.

A1.31 Notice of 8 February 2017 regarding interconnect technology and services. Request sent to and response received from:

- BT Group – response received on 17 March 2017.

A1.32 Notice of April and August 2017 regarding wholesale call termination. Over 320 requests were sent to telecoms providers. 283 responses were received between May and September 2017.

A1.33 Notice sent during May and June 2017 regarding wholesale call origination and ISDN data. Requests sent to and responses received from:

- BT Group – response received in six tranches on 2 June, 12 June, 20 June, 26 June, 27 June and 28 June 2017.
- Openreach – response received on 31 May 2017.
- Colt – response received in two tranches on 3 July and 6 July.
- EE – response received on 7 July.
- Gamma – response received in two tranches on 21 June and 30 June.
- KCOM – response received in two tranches on 30 June and 4 July.
- Sky – response received on 12 June.
- TalkTalk – response received in two tranches, both on 28 June.
- Virgin Media – response received in two tranches on 14 June and 7 July.
- Vodafone – response received in two tranches on 26 June and 5 July 2017.
- Verizon – response received in two tranches on 18 July and 17 August.

A1.34 Notice of 25 July 2017 regarding volumes of OTT calls. Request sent to and response received from:

- Facebook – response received on 2 August 2017.
- Google, Inc. – response received on 4 August 2017.
- Skype – response received on 9 August 2017.
- Vonage – response received on 24 July 2017.
- WhatsApp, Inc. – response received on 3 August 2017.

A1.35 Notice of 26 July 2017 regarding KCOM'S board paper on voice migration/ Request sent to and received from:

- KCOM – response received on 31 July 2017.

A1.36 Notice of 2 August 2017 regarding interconnect circuit volumes, revenues and costs. Request sent to and response received from:

- BT Group – Response received on 17 August 2017.

A1.37 Notice of 3 August 2017 regarding wholesale call termination. Requests sent to and responses received from:

- six telecoms providers holding allocations of geographic numbers.

A1.38 Notice of 23 August 2017 regarding ISDN reporting. Request sent to and received from:

- BT Group – response received on 6 September 2017.

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A2. Glossary

21CN: BT's next generation network upgrade. The elements of the upgrade related to migrating voice services onto 21CN were postponed.

Access Directive: Directive 2002/19/EC on access to, and interconnection of, electronic communications networks and associated facilities.

Access network: The part of the network that connects to customer premises from the local telephone exchange.

The Act: Communications Act 2003.

Ancillary services: Any additional service that is reasonably necessary to allow a particular network access service to be used.

APCC: Average porting conveyance charges.

APCC Disputes: Ofcom, Disputes between BT and each of Gamma and Vodafone in relation to BT's average porting conveyance charges: Final Determination, 11 November 2015, http://webarchive.nationalarchives.gov.uk/20160704053828/http://stakeholders.ofcom.org.uk/enforcement/competition-bulletins/closed-cases/all-closed-cases/cw_01161/

A-Z Telephony Event Charging (AZTEC): BT's system for charging calls to/from its network.

Bandwidth: In digital telecommunications systems, the rate measured in bits per second (bit/s), at which information can be transferred.

Basket: A set of services where the charge control is applied to the total revenue from those services in a given year, subject to a specified compliance formula.

Benchmark FTR: Under the 2013 NMR, BT's FTR (which until 30 September 2016 was subject to a charge control).

BEREC: Body of European Regulators of Electronic Communications, a body of the European Union.

BU: Bottom-up.

Caller Display: A wholesale service provided by BT to other providers that enables them to provide retail CLI services.

Capital expenditure (capex): The firm's expenditure on fixed assets, often measured as a total amount over the course of the financial year.

CBP: Countervailing buyer power.

Charge control: A control that sets the maximum price that a telecoms provider can charge for a particular product or service. Most charge controls are imposed for a defined period.

Calling Line Identification (CLI): Data about the calling party, in particular the telephone number that has initiated the call.

CMR: Communications Market Report.

Common costs: Costs that are shared across multiple services supplied by a firm.

Communications Provider (CP): A person that provides an electronic communications network or service as defined in the Act.

Cost orientation: The principle that the price charged for the provision of a service should reflect the underlying costs incurred in providing that service.

Consumer Price Index (CPI): The official measure of inflation of consumer prices in the UK.

CPL: BT's Carrier Price List available at: https://www.btwholesale.com/pages/static/help-and-support/pricing/carrier-price-lists.htm.

Calling Party Pays (CPP): An arrangement where the calling party (and not the called party) pays a charge when a call is made.

Carrier Pre-Selection (CPS): A facility offered to customers which allows them to choose for certain call types to be carried by a telecoms provider other than their access provider (that they select in advance) without having to dial a routing prefix.

Customer Sited Interconnect (CSI): A type of interconnect circuit. BT builds a link to the telecoms provider's site and uses it to provide individual 2Mbit/s interconnect as required. It is used in conjunction with IBCs.

Current Cost Accounting Fully Allocated Cost (CCA FAC): An approach used to measure a company's costs.

Dampening factor: A divisor applied to a growth rate in order to reduce growth year-on-year, in order to slow down three-year trends to ensure that they are consistent with plausible and stable long-run levels.

Digital Local Exchange (DLE): The telephone exchange to which customers are directly connected via a remote concentrator unit.

DDI: Direct dial-in numbers.

Distributed Long Run Incremental Cost (DLRIC): The LRIC of the individual service with a share of some costs which are common to other services over BT's core network.

Distributed Stand Alone Cost (DSAC): An accounting approach estimated by adding to the DLRIC a proportionate share of the inter-increment common costs. Rather than all common costs shared by a service being allocated to the service under consideration, the common costs are instead allocated amongst all the services that share the network increment.

EC: European Commission.

Economic Depreciation (ED): An approach to depreciation that considers costs over the entire economic life of the network and attempts to match the profile of cost recovery of an asset to the profile of that asset's utilisation. This differs from accounting depreciation that allocates some fixed proportion of costs to each year of use without accounting for changes in utilisation in different years.

Element Based Charging (EBC): An approach to charging for telephony calls where the total charge is calculated by adding together charges for the use of individual network elements. This approach was used by BT and has been replaced by AZTEC.

EE: Everything Everywhere Limited, now part of BT plc.

EEA: European Economic Area.

EIA: Equality impact assessment.

End-user: The final consumer of a product or service.

Fully Allocated Cost (FAC): An accounting approach under which all the costs of the company are distributed between its various products and services. The fully allocated cost of a product or service may therefore include some common costs that are not directly attributable to the service.

FAMR: Fixed Access Market Reviews.

FCS: Federation of Communication Services.

F&R: Fair and reasonable.

FTR: Fixed termination rate – the wholesale charge levied by fixed telecoms providers for WCT.

FAEL: Fixed analogue exchange lines.

Fibre To The Cabinet (FTTC): An access network structure in which optical fibre extends from the local exchange to a flexibility point in the BT network known as a cabinet. The cabinet is usually located a few hundred metres from the subscriber's premises. The remaining part of the access network from the cabinet to the customer is usually copper wire but could use another technology, such as wireless.

Fibre To The Premises (FTTP): An access network structure in which optical fibre runs from the local exchange to the end user's house or business premises. The optical fibre may be point-to-point – there is one dedicated fibre connection for each home – or may use a shared infrastructure. Sometimes also referred to as Fibre To The Home (FTTH).

Framework Directive: Directive 2002/21/EC on a common regulatory framework for electronic communications networks and services.

General Condition (GC): One of the General Conditions of Entitlement imposed under the Act, which apply to all communications providers or all communications providers of a particular type. See https://www.ofcom.org.uk/phones-telecoms-and-internet/information-for-industry/telecoms-competition-regulation/general-authorisation-regime.

Generic Ethernet Access (GEA): BT's wholesale product providing telecoms providers with access to broadband products provided over its FTTC and FTTP networks.

Herfindahl-Hirschman Index (HHI): A measure of the concentration within a market. It is the sum of the squares of the market shares of operators, with a lower value on the index indicating that market share is spread across more operators and a higher value indicating that few operators account for most of the market share.

Historic Cost Accounting (HCA): A method of accounting under which assets and liabilities are recorded at the values at which they were first acquired.

Hypothetical Monopolist Test (HMT): A tool used to identify demand-side and supply-side substitutes.

Hull Area: The area defined as the 'Licensed Area' in the licence granted on 30 November 1987 by the Secretary of State under Section 7 of the Telecommunications Act 1984 to Kingston upon Hull City Council and Kingston Communications (Hull) plc (KCOM).

Indirect Access (IA): A facility that allows a customer to choose for calls to be carried by a telecoms provider other than their access provider, on a call by call basis, by dialling a routing prefix (a four-digit number).

Interconnection Extension Circuit (IEC): A type of interconnect circuit. IECs build out from a POC provided via ISI and allow telecoms providers to extend their interconnection network beyond the building to which they have built their own network. IECs are provided at 2Mbit/s capacity and are used in conjunction with IBCs.

Incremental costs: The incremental costs of a service are the difference between the total costs in a situation where the service is provided and the costs in another situation where the service is not provided.

Interconnection: The linking (whether directly or indirectly by physical or logical means) of one network and another, enabling end-users of different networks to communicate with one another and to access services provided on a different network.

Interconnect circuits: Physical infrastructure to connect exchanges (switches) of two telecoms providers to allow traffic to pass.

Interconnect services: Services that BT has developed with industry to provide access to its interconnect circuits.

Internet Protocol (IP): Packet data protocol used for routing and carriage of messages across the internet and similar networks.

IPEX: BT's IP Exchange.

Interconnect Services Basket (ISB): The ISB is the set of interconnection products that are subject to the interconnect circuits charge control. In the ISB we account only for the interconnect circuits connected at BT terminating or originating switches, this is, in general, the DLEs.

Intra Building Circuit (IBC): A 2 Mbit/s connection between a telecoms provider's transmission infrastructure and switch. For interconnection with BT, an interconnect circuit comprises an IBC at either end with the transmission link being provided by a CSI, IEC or ISI circuit.

ISDN: Integrated Services Digital Network. A digital telephone line service that supports telephony and switched data services.

ISDN2: Provides an ISDN service with two channels, plus one signalling channel over a common digital bearer circuit.

ISDN30: Provides an ISDN service with up to 30 channels, plus one signalling channel over a common digital bearer circuit.

In-Span Interconnection (ISI): A type of interconnect circuit. To provide ISI, a telecoms provider builds its own network up to a Point of Connection (POC), generally located just outside a BT exchange. BT then connects its network to the POC. Individual interconnect circuits of 2Mbit/s

capacity are then provided via the ISI link. An Intra Building Circuit (IBC) is required at each end of this 2Mbit/s circuit to provide connection onto the interconnecting switches.

Internet service provider (ISP): A company that provides customers with Internet access.

Kbit/s: Kilobits per second.

Key Performance Indicator (KPI): A measure of performance of an important aspect of a service or operational process.

Local loop: The access network connection between the customer's premises and the local serving exchange, usually two copper wires twisted together (known as a twisted copper pair).

Local Loop Unbundling (LLU): A process by which a dominant provider's local loops are physically disconnected from its network and connected to a competing provider's networks, enabling other providers to use the local loop to provide services.

Long-run Incremental Costs (LRIC): Only those costs which are caused by the firm's provision of a defined increment or service including fixed costs specific to that increment or service – i.e. those costs that would not be incurred if the firm was structured in such a way as not to provide that service, while still producing all other services and products that are currently produced.

LRIC+: The long run (average) incremental costs plus a mark-up for the recovery of shared and common costs (often in the form of an equi-proportionate mark-up). LRIC+ should be taken to mean the same as LRAIC+ (a term used by some other NRAs).

LTC: Local-tandem conveyance.

Main Distribution Frame (MDF): A piece of equipment in a BT local exchange that allows local loops to be connected to network equipment within the exchange building.

Mbit/s: Megabits per second.

Mean Capital Employed (MCE): The average net assets during the year.

Metallic Path Facility (MPF): The provision of access to the copper wires from the customer premises to a BT MDF that covers the full available frequency range, including both narrowband and broadband channels, allowing a competing provider to provide the customer with both voice and data services using the dominant provider's local loop.

Mobile Call Termination (MCT): A wholesale service provided by a mobile telecoms provider to connect a call to a recipient on its network.

Mobile Termination Rate (MTR): The wholesale charge levied by mobile telecoms providers for MCT.

Narrowband access markets: A collective term used to refer to the WFAEL, ISDN2 and ISDN30 markets.

NCC: Network Charge Controls.

Network Interoperability Consultative Committee (NICC): A technical forum for the UK communications sector that develops interoperability standards for public communications

networks and services in the UK. It is an independent organisation owned and run by its members, which include Ofcom.

NGCS: Non-geographic call services, which are services provided using numbers that are not linked to a specific location (03,05, 08, 09, 116, 118 and certain 07 numbers).

NGS: Next Generation Switches.

Next Generation Access (NGA): A new or upgraded access network capable of supporting much higher capacity broadband services than traditional copper access networks, generally using optical fibre.

Next Generation Network (NGN): A network that uses IP technology to provide multiple services over a single platform.

NMR: Narrowband Market Review.

Nominated In-Span Interconnect (Nominated ISI): Similar to an ISI connection, except that BT builds out its network some way in order to meet the telecoms provider's network. The telecoms provider pays for this extension from the BT exchange to the nominated POC.

NPV: Net present value.

National Regulatory Authority (NRA): The communications regulatory body for each EU Member State assigned tasks under the Framework Directive. Ofcom is the NRA for the United Kingdom

NTS: Number Translation Services. Services generally using NGCS numbers, where the dialled number is analysed and translated into a routing number (which may be a geographic number, mobile number or international number, for example), based on applying features such as time of day routing, interactive services or distribution of calls across multiple locations, as requested by the customer receiving the calls.

OBR: Office of Budget Responsibility.

Office of the Telecommunications Adjudicator (OTA2): An independent body that facilitates discussion between telecoms providers on operational issues related to new and existing telecoms products and services.

Operating expenditure (opex): Costs reflected in the profit and loss account excluding depreciation financing costs such as interest charges.

OSS/BSS: Operations and Business Support Systems.

Over the top (OTT): A service that allows end-users to make and receive voice calls using an internet connection where the service is provided independently of the provision of the internet connection.

Point of Connection (POC): The demarcation point between two telecoms providers' networks.

POI: Point of interconnection.

Ppm: Pence per minute.

Product Management, Policy and Planning (PPP): Overheads associated with marketing activities, customer service management, billing and finance activities directly related to the regulated service.

Public Switched Telephony Network (PSTN): The telephony network used to provide telephone calls using (or emulating) circuit-switching and using telephone numbers to identify subscribers or called locations, allowing all customers connected to the network to call all other customers.

Rate of Return (RoR): The ratio of money gained or lost (whether realised or unrealised) on an investment relative to the amount of money invested.

Regulatory Asset Value (RAV): The value ascribed by Ofcom to the capital employed in the relevant business.

Regulatory Financial Statements (RFS): The financial statements that BT is required by Ofcom to prepare, have audited and publish.

Reference Offer (RO): The terms and conditions on which the Dominant Provider will enter into an Access Agreement.

RoBT: Rest of BT.

Return On Capital Employed (ROCE): The ratio of accounting profit to capital employed. The measure of capital employed can be either Historic Cost Accounting (HCA) or Current Cost Accounting (CCA).

Retail Price Index (RPI): Measure of inflation published monthly by the Office for National Statistics. It measures the change in the cost of a basket of retail goods and services.

SDH: Synchronous Digital Hierarchy. A standardised protocol for transmitting data across a TDM network.

Shared Metallic Path Facility (SMPF)/shared access: The provision of access to the copper wires from the customer's premises to a BT MDF that allows a competing provider to provide the customer with broadband services, while BT continues to provide the customer with conventional narrowband communications.

SIA: Revised Standard Interconnection Agreement – BT's standard terms and conditions for the provision of interconnection and related services.

Significant Market Power (SMP): The European Directives require NRAs to determine whether operators have significant market power and impose appropriate regulatory obligations in such cases. An undertaking will have significant market power if, either individually or jointly with others, it enjoys a position equivalent to dominance, that is to say a position of economic strength affording it the power to behave to an appreciable extent independently of competitors, customers and ultimately consumers.

SME: Small and medium enterprises.

SML: Service Maintenance Level.

SMP Guidelines: EC guidelines on market analysis and the assessment of significant market power under the Community regulatory framework for electronic communications networks and services (2002/C165/03).

SSNIP: Small but significant non-transitory increase in price.

Service Provider (SP): An individual or organisation using a non-geographic number to provide a service to consumers and who is the recipient of the non-geographic call from the consumer wishing to access that service.

Superfast broadband: A broadband connection that can support a maximum download speed of 30 Mbit/s or greater.

Telecoms provider: Another term for a Communications Provider.

TI: Traditional Interface for leased lines.

Time Division Multiplex (TDM): A method of putting multiple data streams in a single signal by separating the signal into many segments, each having a very short duration. Each individual data stream is reassembled at the receiving end based on the timing.

Voice over Internet Protocol (VoIP): the traffic method of carrying voice calls on fixed and mobile networks by packetising speech and carrying it using IP.

Virtual Unbundled Local Access (VULA): The remedy imposed on BT in the 2014 FAMR to require it to provide access to its FTTC and FTTP deployments. Openreach provides GEA to meet this obligation.

Weighted Average Cost of Capital (WACC): The rate that a company is expected to pay on average to all its security holders to finance its assets.

WCO: Wholesale fixed call origination services.

WCT: Wholesale fixed geographic call termination services.

Wholesale Fixed Analogue Exchange Line (WFAEL): A narrowband analogue access connection between a customer's premises and a local exchange.

Wholesale Line Rental (WLR): The service offered by BT to other UK telecoms providers to enable them to offer retail line rental services in competition with BT's own retail services.

Wholesale Local Access (WLA): The provision of broadband and telephony services at a fixed location from a point of aggregation of subscriber connections to a home or business premises.

A3. Relative costs of MPF and WLR

A3.1 In section 6 we considered the costs to telecoms providers of switching between alternative wholesale services in order to sell line and voice services downstream. A significant element of these costs are the network costs, based on wholesale charges. In this annex we consider the network costs of switching from WLR to MPF (at exchanges where MPF is already present) in response to an increase in the price of WLR.

A3.2 This discussion is not intended as a definitive evaluation of the viability of switching, as other costs and commercial considerations may also be relevant, but provides an illustration of the circumstances in which switching to MPF might become viable. Our analysis applies to existing LLU operators such as Sky and TalkTalk; which might switch more of their existing or prospective customers to supply using MPF. It also applies to telecoms providers to whom existing LLU operators may sell wholesale services, though in this case we note that other costs of reselling may apply. We have made some simplifying assumptions regarding capacity constraints, margins, uniform pricing and residential call volumes, which are discussed below.

A3.3 Our analysis suggests that, depending on the assumed customer lifetime, it could be cost effective to migrate customers from WLR and WCO to MPF in response to relatively modest increases in the combined price of WLR and WCO.[7] For example, based on a two-year customer lifetime and using the average volume of calls made on a fixed line to estimate the cost of providing WCO,[8] a price rise of 5% would be sufficient to render it cost effective to switch to MPF (assuming there is capacity in the exchange to do so). Longer customer lifetimes make it more cost-effective for a provider to switch a customer from WLR and WCO to MPF as there is a longer timeframe over which a provider can benefit from the lower ongoing cost of MPF. For customer lifetimes of three years or more, our estimates suggest that MPF is a cost-effective choice at current WLR and WCO prices (i.e. even without a price increase in WLR and WCO, after this period of time MPF is a lower cost solution for alternative providers to retail access line and calls).

A3.4 Our recent consultations on the WLA charge controls may have implications for the price of MPF and the migration charge in the future and so may affect this analysis.[9] Some of the changes we have proposed would affect the cost-based charges of MPF (such as the proposals for funding the costs of investment in network expansion,[10] and the costs of the

[7] Our estimates have considered increases in the combined price of WLR and WCO, although the majority of the price increase will be due to the price of WLR.
[8] As shown in Figures 3.1 and 3.2, the total number of analogue fixed lines was 30.3 million in 2016, while outgoing fixed call volumes were 65 billion minutes. We estimate 2,145 minutes of calls were made on a fixed voice line.
[9] Ofcom, March 2017. *Wholesale Local Access Market Review – Consultation on the proposed market, market power determinations and remedies, Volumes 1 and 2*. https://www.ofcom.org.uk/consultations-and-statements/category-1/wholesale-local-access-market-review.
[10] 2017 WLA Consultation.

MPF migration charge[11]), other proposals would affect the costs of both MPF and WLR (for example, the treatment of non-domestic rates and our quality of service proposals). Overall, these proposals may alter the results of our calculations, but are not likely to change the overall conclusion. For example, following the proposed changes, based on a customer lifetime of two years, a combined WLR and WCO price rise of 3% would make migration to MPF cost-effective.

Potential for further substitution to MPF

A3.5 Telecoms providers supply fixed voice services using a variety of wholesale products and infrastructure. BT uses WLR to provide fixed voice services to its retail customers as do many other providers of voice services. Sky and TalkTalk use their own MPF networks to supply most of their customers (although they also use WLR). Virgin Media uses its cable network.

A3.6 We currently estimate that Sky and/or TalkTalk are already present via LLU at 55% of exchanges, covering 95% of premises.[12] Sky and TalkTalk supply the majority of their existing voice customers, and are able to compete for new customers in most parts of the country, using their MPF networks.[13]

A3.7 An increase in the combined price of WLR and WCO will increase the incentive for Sky and/or TalkTalk to sell wholesale services based on their MPF networks to other retailers of voice services. TalkTalk already provides some wholesale voice services, based on MPF, to third parties. For example, TalkTalk sold [✂]m MPF lines to [✂] in Q4 2016/17.[14]

A3.8 There are a number of other factors that would affect substitution to MPF in practice. These may vary depending on whether MPF is being self-supplied or bought from wholesale providers. For example, wholesale MPF providers (i.e. Sky and TalkTalk) would need to incur costs to develop systems and processes that provision and bill for wholesale services as part of a third party wholesale arrangement, and our calculations have not quantified such additional costs.

Network cost of migrating voice customers to MPF

A3.9 When a line is switched from WLR to MPF the network operator will pay a migration charge, will cease to pay both the WCO charge and the WLR rental charge and will start paying the MPF charge instead. The overall cost effectiveness of switching to MPF will therefore depend on three factors: the level of the migration charge, the difference in

[11] Ofcom, 2017. *Wholesale Local Access Market Review – Further consultation on proposed charge control for wholesale standard superfast broadband.* https://www.ofcom.org.uk/__data/assets/pdf_file/0023/106448/Proposed-charge-control-for-wholesale-standard-and-superfast-broadband.pdf
[12] Based on data provided by BT and Virgin Media for the WBA market review. For more detail, please see Table A8.1 in Annex 8 of the 2017 WBA Market Review Consultation: https://www.ofcom.org.uk/__data/assets/pdf_file/0013/103180/wba-consultation.pdf
[13] Sky and TalkTalk supply [✂]% and [✂]% of their respective total analogue retail lines using WLR. Source: Sky response dated 12 June 2017 to the 6th NMR s.135 notice; TalkTalk response dated 28 June 2017 to the 8th NMR s.135 notice.
[14] TalkTalk response dated 28 June 2017 to the 8th NMR s.135 notice.

annual charges (i.e. the difference between the MPF rental and the combined WLR rental and WCO charges) and the expected customer lifetime. If the value of the savings over the lifetime of the customer contract is larger than the value of the migration charge, then it will be cost effective to switch to MPF.

A3.10 We have excluded costs associated with increasing MPF capacity, such as tie-cable and co-mingling charges. Our analysis assumes that there would be sufficient spare capacity in exchanges to migrate WLR customers to MPF without providers needing to incur the cost of new equipment. For supplying a single additional customer, we would not expect such costs to change, however, if migrating a larger increment of subscribers in an exchange to MPF, such costs could become relevant.

A3.11 As a conservative assumption, we have used the single migration charge in our calculations.[15] We have also used the lower rental charge of WLR Basic (rather than a WLR Premium line).

A3.12 In Table A3.1 below, we present our estimates of the current ongoing costs of using WLR and WCO and MPF to deliver fixed voice services. At current prices, the ongoing cost of a WLR based voice service (using WLR and WCO) based on the average volume of calls made on a fixed voice line (£96.78 per annum) is more expensive than MPF (£84.38 per annum). This implies an ongoing saving from using MPF of £12.40 per annum.[16] Although standalone landline customers make more calls than the average fixed voice customer, the results are similar (£96.86 per annum with an ongoing saving using MPF of £12.48). This suggests that once migration has occurred, it is more cost-effective for a telecoms provider to use MPF.

Table A3.1: Current ongoing network costs of retailing to fixed voice customers

	Standalone fixed line customer (WLR and WCO)	Average fixed line customer (WLR and WCO)	MPF	Saving from using MPF	
				Standalone	Average
Rental (£/ year)	£ 86.72	£86.72	£84.38		
WCO (£/year)	£10.14[17]	£10.06	N/A		
Total	£96.86	£96.78	£84.38	£12.48	£12.40

Source: WLR and current MPF rental prices: Available online, https://www.openreach.co.uk/orpg/home/products/pricing/loadPricing.do.WCO price per minute: BT's Regulatory Financial Statements. Average volume of calls made by standalone landline customers: data provided to the Standalone Landline Telephone Review. WCO volume data: Ofcom/operator data

[15] Where there are many lines being migrated in a particular exchange the lower bulk migration charge may apply, which would reduce the costs of migration by approximately one-third.
[16] This is based on MPF SML1. We consider this to be the more likely substitute than MPF SML2 as it has the same service level as WLR SML1 and MPF SML1 is more commonly used.
[17] Based on data provided for the Standalone Landline Telephony Services Market Review, we have estimated 2,163 call minutes per year per line for standalone landline customers. These calculations assume constant call volumes.

A3.13 However, the migration service charge for MPF (when the line was previously provided through WLR) is currently £30.26.[18] Migration costs do not affect the ongoing cost, but may discourage switching to MPF if a provider cannot recover this upfront cost over a customer's lifetime. The longer the average customer lifetime, the easier it is for a provider to recover the initial cost of migration. Data from the 2016 Switching Tracker suggests that broadband and landline customers have switching rates of 9% and 8% respectively.[19] This suggests that the average customer lifetimes are between 11 and 13 years, if all consumers switched with equal probability.

A3.14 We have calculated the net present value (NPV) to a provider switching from WLR to MPF for a range of WLR and WCO price increases and customer lifetimes. A positive NPV implies that migrating to MPF would lead to savings for a provider. To calculate the NPV associated with migrating a customer we took three steps:

i) We calculated the cost difference each year between MPF and WLR and WCO. As a conservative (higher cost) simplification, year zero includes only the up-front cost of migration, with subsequent years calculating the ongoing annual cost saving of MPF.

ii) We then applied a 7.4% discount rate to these cost differences to reflect the range of time periods associated with the costs.[20]

iii) Finally, we looked at the cumulative saving or NPV implied by a range of customer lifetimes and price increases i.e. the aggregate NPV associated with a customer of five years, assuming a 10% price increase for WLR and WCO, for example.

A3.15 Based on our current estimates, and using the average volume of calls made on a fixed voice line, a customer lifetime of three years or more is sufficient to make it cost-effective to switch to MPF under current WLR and WCO prices. Even based on shorter customer lifetimes however, a two-year customer lifetime appears to be sufficient to make migration to MPF cost-effective following a 5% price increase in WLR and WCO. This is shown in Table A3.2 below (shading indicates it would be cost-effective for a provider to switch to MPF).

[18] BT. *P*rice *List – Local Loop Unbundling Pricing.* https://www.openreach.co.uk/orpg/home/products/pricing/loadProductPriceDetails.do?data=totid5BwFmkf9vLcBITRyZF9loRxWIbIKK6V7YWmlYAlMnGHsqdC0vzO163bJmh34D91D7M0q8u%2F%0AIlSgtIFAKw%3D%3D [accessed 5 October 2017].
[19] Ofcom, 2017. *Switching Tracker*. https://www.ofcom.org.uk/__data/assets/pdf_file/0024/107178/Switching-Tracker-2017-Data-tables.pdf.
[20] This is consistent with the real (CPI deflated) WACC used in the 2017 WCT model.

Table A3.2 Discounted cumulative NPV of switching to MPF

% increase in WLR and WCO price	Customer lifetime 0	1	2	3	4
0%	-£ 30.26	-£ 18.41	-£ 7.37	£ 2.90	£ 12.47
1%	-£ 30.26	-£ 17.50	-£ 5.63	£ 5.43	£ 15.73
2%	-£ 30.26	-£ 16.60	-£ 3.88	£ 7.96	£ 18.99
3%	-£ 30.26	-£ 15.70	-£ 2.13	£ 10.49	£ 22.25
4%	-£ 30.26	-£ 14.79	-£ 0.39	£ 13.02	£ 25.51
5%	-£ 30.26	-£ 13.89	£ 1.36	£ 15.55	£ 28.77
6%	-£ 30.26	-£ 12.98	£ 3.10	£ 18.08	£ 32.03

Source: Ofcom estimates.

Proposed changes to charges for MPF

A3.16 The 2017 WLA Consultation proposed changes to the MPF rental charges.[21] These would reduce the MPF rental from £84.38 to £83.70.

A3.17 We also recently consulted on proposals to recover the costs of rollout of BT's network expansion from all Openreach broadband lines. These affect the ongoing cost of using MPF, as under our current proposals the price of MPF will increase due to the additional costs included in the WLA charge control.[22] The additional costs, and the associated increase in the MPF charge, will increase over the control period. We estimate the annual MPF rental charge will increase by £0.39 per annum in 2018/19 and will be £1.93 per annum higher in 2020/21 (£85.63) as a result of these additional proposals.[23] The prices of WLR and WCO will not be affected as they are pure voice products.

A3.18 As we are concerned in this review with the cost of delivering voice services, our estimates of the average volume of calls made from a fixed voice line assume that the wholesale costs of broadband (SMPF or WBA) are not changed from their current levels. If the price cap for SMPF services is removed, as proposed in the 2017 WLA Consultation, prices for these broadband services may increase, which would provide a further incentive to switch to MPF.

[21] 2017 WLA Further Consultation, page 81.
[22] Where MPF is combined with FTTC, the network expansion charge will not be applied to MPF (as it would be recovered from the FTTC component).
[23] As a conservative and simplifying assumption, we have assumed in our analysis the rental charge will increase by £1.93 in 2018/19.

A3.19 In Table A3.3 below we present our estimates of the ongoing costs of a WLR based service and MPF, taking into account the net impact of the WLA proposals. By increasing the annual rental of MPF to £85.63, this reduces the ongoing savings from using MPF to £11.15 based on the average volume of calls made on a fixed voice line and to £11.23 based on the volume of calls made by a standalone landline customer.

Table A3.3 Net impact of 2017 WLA Consultation proposals on ongoing network costs

	Standalone fixed line customer (WLR +WCO)	Average fixed line customer (WLR+WCO)	Proposed MPF charges	Savings from using MPF	
				Standalone	Average
Rental (£/ year)	£ 86.72	£86.72	£85.63		
WCO (£/year)	£10.39	£10.06	N/A		
Total	£96.86	£96.78	£85.63	£11.23	£11.15

Source: As at Figure A3.1. Revised MPF charges based on Ofcom estimates.

A3.20 In the 2017 WLA Consultation, we also proposed a reduction in the one-off WLR to MPF migration charge, from £30.26 to £24.24. As shown in Table A3.4 below, our results suggest that we can still expect MPF to be a feasible substitute for WLR and WCO across a range of expected customer lifetimes after taking into account the net impact of the WLA Consultation proposals. A customer lifetime of three years or more would still make it cost effective to switch to MPF at current WLR and WCO prices. Based on a customer lifetime of two years, a WLR and WCO price rise of 3% would render migration to MPF cost-effective.

Table A3.4: Net impact of 2017 WLA Consultation proposals on discounted cumulative NPV of switching to MPF

% increase in WLR and WCO price	Customer lifetime									
	0		1		2		3		4	
0%	-£	24.24	-£	13.86	-£	4.19	£	4.81	£	13.19
1%	-£	24.24	-£	12.96	-£	2.45	£	7.33	£	16.44
2%	-£	24.24	-£	12.06	-£	0.71	£	9.85	£	19.69
3%	-£	24.24	-£	11.15	£	1.03	£	12.38	£	22.94
4%	-£	24.24	-£	10.25	£	2.77	£	14.90	£	26.19
5%	-£	24.24	-£	9.35	£	4.51	£	17.42	£	29.44
6%	-£	24.24	-£	8.45	£	6.25	£	19.94	£	32.68

Source: Ofcom estimates

A4. WCT cost model approach and design

A4.1 This annex sets out our approach to developing the new WCT cost model (the "2017 WCT model"), which is published alongside this statement. We have used this model to calculate the LRIC of WCT and set the charge control.

A4.2 We have modelled the cost of a hypothetical national NGN using a bottom-up cost model. We have based this model on the 2013 NCC model[24], updating only those assumptions that have an impact on the LRIC of WCT.[25]

A4.3 In order to update the 2013 NCC model we have collected data using our formal powers and updated the data following the 2016 NMR Consultation. We requested information from BT, Gamma, Sky, TalkTalk, Virgin Media and Vodafone relating to:[26]

- historical call duration during the network busy hour;
- historical network asset costs (capital and operating costs);
- asset capacity and utilisation; and
- historical asset cost trends.

A4.4 The remainder of this annex is structured as follows:

- an explanation of our modelling aims and technology choice;
- an overview of the 2017 WCT model and its constituent modules, namely:
  - Module 1: Scenario control and traffic;
  - Module 2: Network dimensioning and cost; and
  - Module 3: Depreciation; and
- an explanation of our approach to verifying the outputs of the model.

A4.5 Annex 5 summarises the 2017 WCT model outputs, sensitivity and scenario analysis.

Modelling aims and technology choice

A4.6 The purpose of the 2017 WCT model is to forecast the cost of providing WCT for an efficient national fixed telecoms provider. The forecast costs derived from our 2017 WCT model are then used to inform our decision to set a charge control on WCT.

[24] This model was published on our website and is available at: https://www.ofcom.org.uk/consultations-and-statements/category-2/nmr-13.
[25] Although the model remains capable of calculating LRIC+ costs (and costs of origination) we have only updated the aspects of the model than affect the WCT LRIC results. We have not reviewed the approach to the allocation of common costs and have not verified the LRIC+ or origination results. We therefore do not consider that it would be appropriate to use the 2017 WCT model to calculate the LRIC+ of WCT or WCO, despite its similarity to the 2013 NCC model which did calculate these outputs.
[26] We have gathered data from these telecoms providers as the 2013 NCC model was based on information from these same telecoms providers. Given they are the largest telecoms providers in terms of traffic, we believe they provide a reasonable basis on which to base the assumptions of the 2017 WCT model.

Technology choice

A4.7 In order to build a network cost model, we need to decide which network technology or combination of technologies to model. When choosing which technology to model, we have borne in mind:

- our economic objectives when setting cost based charges;
- the 2009 EC Recommendation;
- the technology modelled in the 2013 NCC model and market developments since that time; and
- stakeholder responses to the 2015 CFI and 2016 NMR Consultation.

Economic objectives in setting cost-based charges

A4.8 As explained in the 2016 NMR Consultation, in setting a charge control, consistent with our duties, our main objectives are:

- allocative efficiency, meaning prices reflect forward looking marginal (or incremental) costs.
- productive efficiency, meaning that telecoms providers face incentives to minimise costs and there are efficient 'build or buy' signals.
- dynamic efficiency, meaning that there is scope for innovation and investment. Delivering dynamic efficiency in regulated markets typically involves providing the opportunity (but not a guarantee) for firms to recover efficiently-incurred costs since this will affect future incentives to invest.
- effective competition, meaning that telecoms providers able to provide services more efficiently than BT can enter using their own resources and infrastructure, but that we do not restrict the ability of BT or other telecoms providers already operating in regulated markets from competing.

A4.9 We recognise that tension can exist between these objectives. In essence, modelling the costs of an ongoing TDM network and using an anchor pricing approach (as we did in the 2009 NCC) might be allocatively efficient if these assets continue to be used. However, modelling an NGN using a modern equivalent asset (MEA) approach (as we did in 2013) seeks to set regulated prices as if the SMP market were contestable and hence fits well with the principle of effective competition in particular.[27]

The 2009 EC Recommendation

A4.10 The 2009 EC Recommendation states that: [28]

[27] This trade-off is discussed at length in Annex 5 of the 2013 NMR Statement. See paragraphs A5.38 to A5.41 of that document.
[28] *Commission Recommendation of 7 May 2009 on the Regulatory Treatment of Fixed and Mobile Termination Rates in the EU (2009/3359/EC)*, paragraph 4. http://ec.europa.eu/smart-regulation/impact/ia_carried_out/docs/ia_2009/c_2009_3359_en.pdf. Further detail on this is provided in Section 5.1.1 of the *Commission Staff Working Document accompanying the Commission Recommendation on the Regulatory Treatment of*

> "The cost model should be based on efficient technologies available in the timeframe considered by the model. Therefore the core part of both fixed and mobile networks could in principle be Next-Generation-Network (NGN)-based."

A4.11 In deciding our technology choice for the 2017 WCT model, we have taken due account of this recommendation, as required under section 4A of the Act.

The 2013 NCC model

A4.12 In the 2013 NMR we decided to set charges based on the costs of a hypothetical NGN. We did so on the basis that this was reasonable because:

- NGNs have been the technology of choice for entrants in voice call markets and access seekers would face reasonably efficient build or buy price signals, which in turn should promote effective competition; and
- setting regulated prices independently of BT's incurred costs would provide dynamic and productive efficiency advantages.

A4.13 We also considered that this approach was consistent with the 2009 EC Recommendation.

Consultation responses

A4.14 The main response to the 2016 NMR Consultation on technology choice came from Vodafone, which asserted that BT is adopting (and others may adopt) a model of providing voice via an Analogue Telephony Adaptor rather than the MSAN architecture used by the 2016 WCT model published with the consultation.[29] Vodafone stated that it considers the current approach using an MSAN architecture to be a reasonable proxy currently, but argued that we should reconsider this approach in future reviews.

A4.15 We did not receive any further comments on technological choice, although we note that several stakeholders responded to our 2015 CFI, with none suggesting departing from an NGN.[30]

Analysis and decision on technology choice

A4.16 We consider that setting FTRs with reference to an NGN aligns with our objectives of promoting economic efficiency and competition. It provides regulatory consistency with our 2013 modelling approach and the approach outlined in the 2009 EC Recommendation, and was supported by stakeholders in response to our 2015 CFI. Nevertheless, we note Vodafone's comments about future technological change and agree with Vodafone that this likely to be an issue to be considered as part of the next review.

Fixed and Mobile Termination Rates in the EU – Explanatory Note (2009/600/EC). http://ec.europa.eu/smart-regulation/impact/ia_carried_out/docs/ia_2009/sec_2009_0600_en.pdf.

[29] Vodafone response to 2016 NMR Consultation, part 1, paragraph 12.

[30] See 2016 NMR Consultation, paragraphs A4.15 to A4.17.

Modelling approach and design

Bottom-up model

A4.17 The 2009 EC Recommendation states that:[31]

> "It is recommended that the evaluation of efficient costs is based on current cost and the use of a bottom-up modelling approach."

A4.18 A bottom-up model estimates how much of each type of network equipment is required based on the projected volumes for cost drivers such as subscribers, traffic, or other equipment installed in the network. The parameters which define these relationships between equipment and volumes are sometimes referred to as "network build parameters". The total cost of network equipment is then calculated using a range of evidence (if possible) on the replacement cost of each piece of equipment.

A4.19 In the present context we consider that bottom-up modelling has a number of advantages over the alternative of top-down modelling:[32]

- By using network build parameters, bottom-up modelling allows us to model underlying cost/volume relationships more accurately.
- Typically, it is also more transparent because it is less reliant on the network design or costs of a single operator. The model can therefore be published without the need to redact confidential information.
- Building a bottom-up model allows us to create an efficient forward-looking network, without being unduly constrained in trying to precisely mimic the network of a single operator.

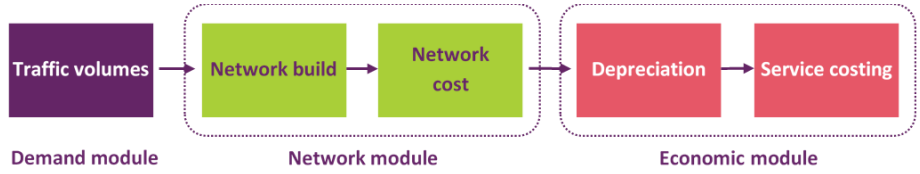
A4.20 We did not receive any consultation comments on this aspect of our approach and have decided to continue using the bottom-up modelling approach we used for the 2013 NCC model. We have changed only those assumptions which drive incremental WCT costs. These updates are discussed in greater detail later in this Annex.

Overview of the model

A4.21 Figure A4.1 below shows the high-level structure of the 2017 WCT model:

[31] 2009 EC Recommendation, Recital 2.
[32] In a top-down model costs are forecast starting with a base year, normally based on a specific operator's costs. These costs are then forecast accounting for volume changes, input price changes, efficiency and an allowance for a return on capital employed.

Figure A4.1: WCT model structure



Source: Ofcom.

A4.22 The demand module forecasts the voice and data traffic that will be carried by all fixed networks. A proportion of this traffic is then allocated to the modelled operator based on a market share assumption.

A4.23 The network module was created for Ofcom by CSMG in 2013.[33] This module incorporates two sections:

- **Network build:** This section uses the traffic volumes from the demand module to forecast how much network infrastructure will be required. We have maintained the original CSMG network dimensioning algorithms for the 2017 WCT model.
- **Network cost:** This section takes the output from the network build calculations and calculates the cost (both operating and capital) of building that network. In the 2017 WCT model, historical asset prices are maintained at the level at which they were set in the 2013 NCC model, with updates since that time. We have taken into account changes in the investment and maintenance costs associated with each asset type, as well as technological developments that improve asset productivity.

A4.24 The economic module includes two sections:

- **Depreciation:** This section uses an economic depreciation algorithm ("Original ED") to determine how the costs of each asset are recovered over time.
- **Service costing:** This stage calculates the yearly costs to be recovered from traffic services based on how much each service uses the network.

A4.25 In order to calculate LRIC, a decremental approach is used. The demand, network and cost modules are run twice, initially with all traffic services and subsequently with all traffic services except call termination. The difference in network costs between the two runs of the model is then used as an input to the economic module to calculate the unit LRIC of termination.

Traffic volumes

A4.26 In an NGN, because voice calls are one service among a number that are provided using a common transport medium (packets routed using IP), the equipment routing calls is, to a large extent, shared between voice and data services. Given the considerable growth in

[33] CSMG, 2013. *Fixed Narrowband Market Review: NGN Cost Modelling.* https://www.ofcom.org.uk/__data/assets/pdf_file/0019/37045/annex_7.pdf. Note that CSMG has since been renamed Cartesian.

packet data traffic (and expected future growth), we expect that data service volumes will be a significant cost-driver in an NGN. It is therefore necessary for us to produce forecasts for data services as well as voice, as explained further below.[34] We only received comments from a single provider, BT, relating to our volumes forecasts.

Voice forecasts

A4.27 The model generates voice traffic forecasts by extrapolating trends underlying the number of active phone/broadband lines per household and business and the volume of calls made per line each year. The model uses the average growth rate over the past three years of historical data to establish trends, with a dampening factor applied.[35]

A4.28 In its response to the 2016 NMR Consultation, BT disagreed with our use of dampening factors and noted that the forecasts presented in the 2013 NMR Statement were consistently higher than what has turned out to be.[36] BT argued that the historical trends have generally displayed constant percentage changes in volumes, and therefore no dampening factors should be applied to our forecasts.

A4.29 We agree with BT that the forecasts in the 2013 NMR Statement turned out to be high relative to the outturn data. In the 2016 NMR Consultation we reduced the base case dampening factors from 1.4 to 1.2, in effect changing our base case forecasts to align with the method used to produce the low case forecasts in 2013. We continue to believe that it is most appropriate to use a dampening factor in producing our base case forecasts in the 2017 WCT model as the current downward linear trend in many forecasts cannot be sustained in the long run. However, in light of the latest data and BT's comments we have decided to further reduce the dampening factors used in the base case from 1.2 to 1.1.

A4.30 In support of the analysis presented in Section 6 we have gathered data from operators regarding ISDN line volumes. We have compared these data to those used in the 2016 WCT model published alongside the 2016 NMR Consultation and identified a systematic underestimation of ISDN line volumes in the model input data. We have accounted for this in the 2017 WCT model by using the aggregate operator data where available and, for years for which we do not have new data, uplifting our original source data by a constant proportion so as to give a consistent data set.

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[34] We note however that we continue to exclude leased line services from the model. We are modelling a hypothetical efficient national fixed provider rather than any specific provider, and not all national or near-national fixed providers have leased line infrastructure. Were we to include leased lines we would expect them to share some common network elements with services we do model but we would not expect a material impact on the LRIC of WCT, which excludes common costs.

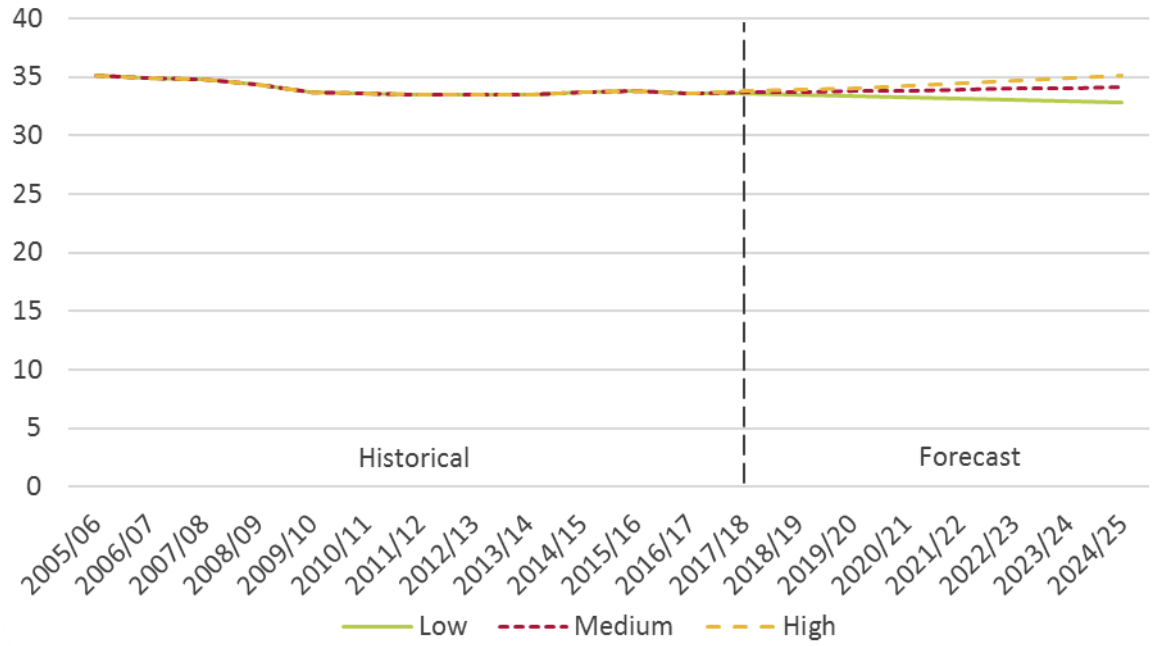
[35] For example, the forecast for annual residential voice usage per line is calculated as:
[Total households] * [Voice lines per household] * [Minutes of voice calls per line per year]. A dampening factor is applied to the growth rate in order to reduce the year-on-year change. We apply a dampening factor in order to smooth the transition to the steady state, and to account for the fact that a linear downward trend (such as in call volumes in recent years) is unlikely to continue in the long run (as this would result in forecasting zero or negative volumes in later years).

[36] BT response to 2016 NMR Consultation, pages 44-46.

A4.31 Figure A4.2 below shows our high, medium and low forecasts for the total number of lines (residential and business).[37] The medium scenario is our base case and assumes a slight increase in the number of lines until 2024/25 (our steady state date), after which the number of lines is held constant. However, this masks two opposing trends, i.e. an increase in the total number of residential lines, and a fall in the total number of business lines.

A4.32 In particular, there has been a greater increase in the number of residential voice lines per household than that anticipated in the 2013 NCC model[38], and a greater than anticipated reduction in the number of business lines and channels per business. The forecasts in the 2013 NCC model were based on data at the time which showed a relatively flat number of lines per household and lines/channels per business. Since then, growth in lines has been slightly faster than household growth, and the reduction in business lines/channels has been faster than seen on average in the years preceding the publication of the 2013 NCC model.

Figure A4.2: Forecast for total number of lines (millions)



Source: Ofcom forecasts based on data collected from fixed operators.

A4.33 Figures A4.3 and A4.4 below show our forecasts for the average annual outgoing voice usage per line for residential and business users respectively. The medium scenario is our base case.

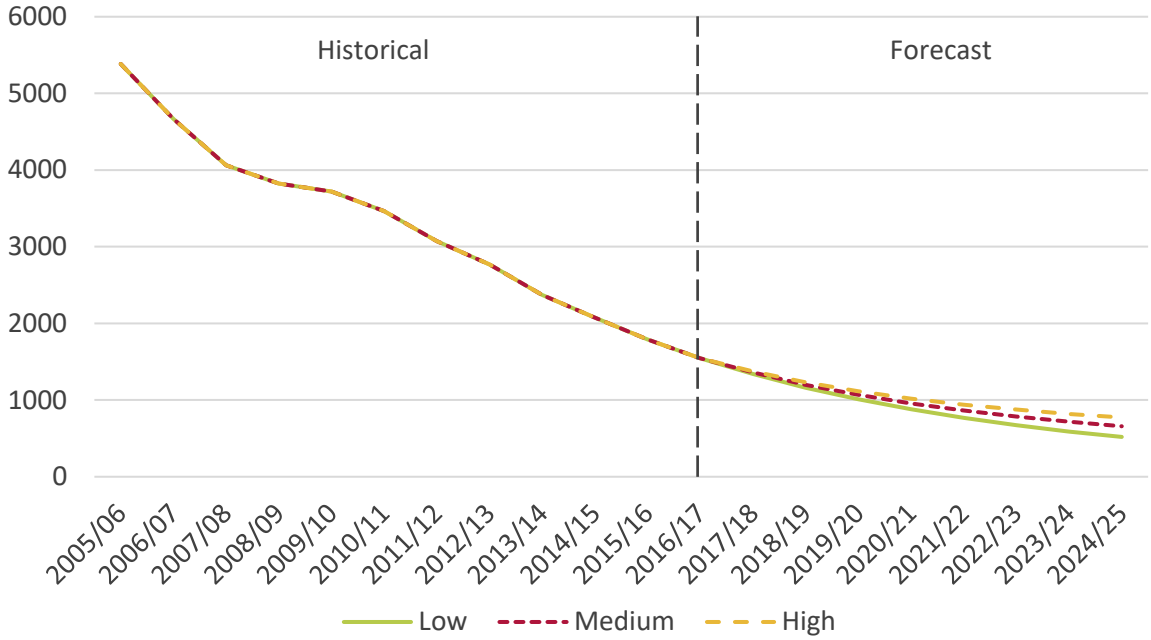
A4.34 The last four years have seen a continued reduction in average residential call usage per line across all call types. As such, our forecast gradual decline in residential usage going

[37] This excludes large business sites, as they are likely to be using leased lines. “Total business lines” includes business voice lines, business ISDN 2 channels and business ISDN 30 channels. "Total residential lines” includes total residential voice lines and total residential ISDN 2 channels. However, the latter is very small (in 2014/15 there were 184 residential ISDN 2 channels).

[38] We have used a higher set of dampening factors to calculate the forecasts for residential lines per household in order to smooth the path to a steady state which has no greater than one line per household.

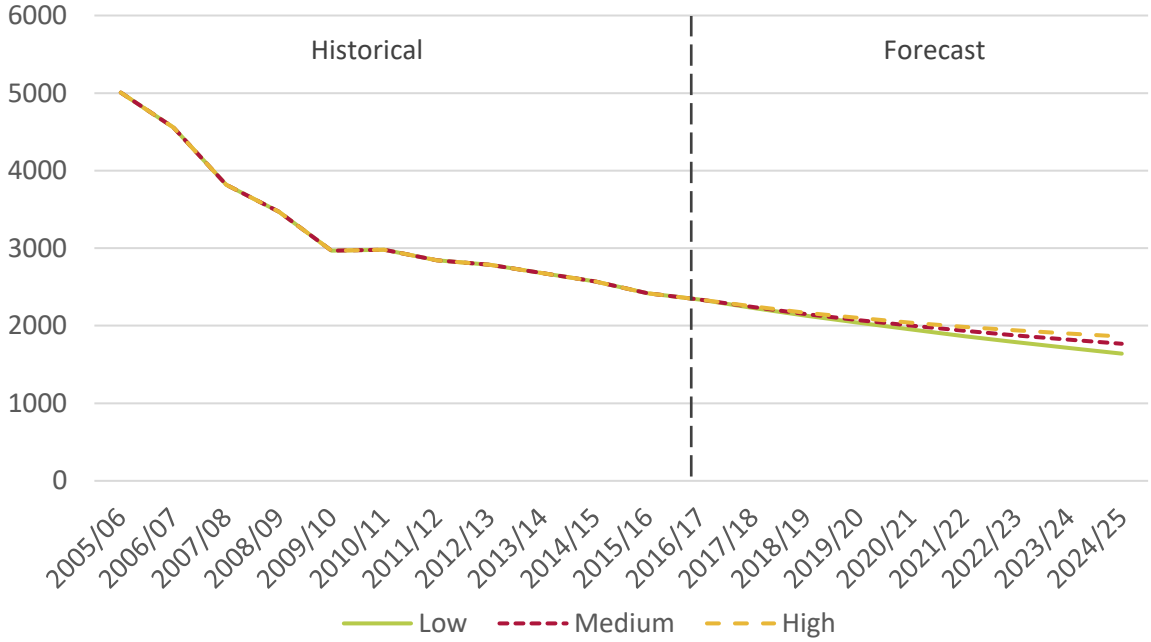
forward starts from a lower base than the 2013 NCC model. Similarly, we forecast a continuing decline of business call usage per line which flattens as we reach the steady state in 2024/25.

Figure A4.3: Forecast for annual average residential outgoing voice usage per line (minutes)



Source: Ofcom forecasts based on data collected from fixed operators.

Figure A4.4: Forecast for annual average business outgoing voice usage per line (minutes)



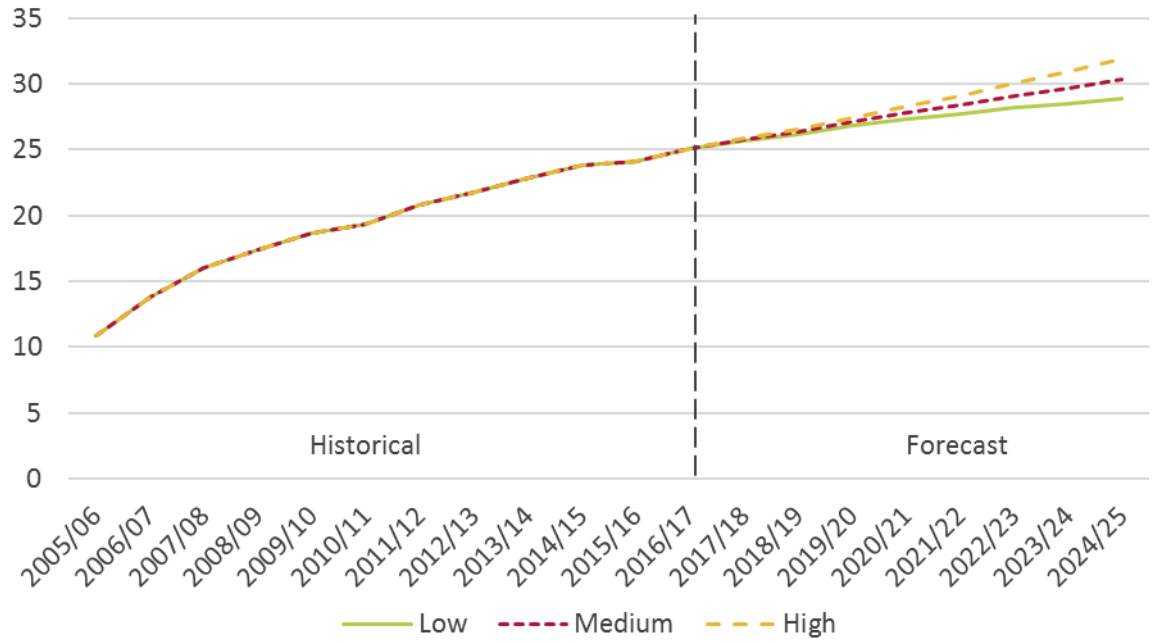
Source: Ofcom forecasts based on data collected from fixed operators. Historical data exclude VoIP and are an approximation as they are based on data from a large number of small providers.

A4.35 We have performed a sensitivity analysis on voice lines and usage (see Annex 5) in which we found that the LRIC of WCT is relatively insensitive to changes in traffic volumes.

Broadband forecasts

A4.36 We present our broadband lines forecast in Figure A4.5 below. The number of broadband lines has continued to increase over the last three years. As discussed above, we have reduced our dampening factors in keeping with those used for voice lines. In our medium scenario, we continue this increase towards 30.3 million broadband lines in 2024/25.[39]

Figure A4.5: Forecast number of broadband lines (millions)



Source: Historical data collected from providers by Market Intelligence, Ofcom forecasts based on data collected from fixed operators.

A4.37 We have used the same forecast peak bit rate per broadband line (in kbit/s) as in the 2013 NCC. This is because LRIC of WCT is not materially affected by changes in the forecast broadband usage, as is shown in our sensitivity analysis in Annex 5.

Market share

A4.38 The market share assumption affects the share of total traffic which will be carried by the modelled operator. This assumption is not explicitly based on any single provider – rather, it is intended to provide a reasonable proxy of the market share an efficient national entrant to the market would expect to reach. We have assumed that the modelled operator will have the same market share for all voice and broadband services.

[39] This translates to approximately 93% residential broadband penetration. We have incorporated an additional constraint in our model that the forecast number of residential broadband lines cannot exceed the forecast number of residential households.

A4.39 The 2009 EC Recommendation is not specific in the approach to be applied in the case of market share for WCT cost modelling. The annex to the 2009 EC Recommendation states:[40]

> "To determine the efficient scale of an operator for the purposes of the cost model, NRAs should take into account that in fixed networks operators have the opportunity to build their networks in particular geographic areas and to focus on high-density routes and/or to rent relevant network inputs from the incumbents. When defining the single efficient scale for the modelled operator, NRAs should therefore take into account the need to promote efficient entry while also recognising that under certain conditions smaller operators can produce at low unit costs in smaller geographic areas. Furthermore, smaller operators that cannot match the largest operators' scale advantages over broader geographic areas can be assumed to purchase wholesale inputs rather than self-provide termination services."

A4.40 In the 2013 NMR Statement we used a base case market share of 33%. We considered it appropriate to use only a market share which would reflect that which a hypothetical network operator could realistically achieve across the market as a whole. We considered evidence of the deployments of different providers from the 2013 WBA Consultation, which showed that four providers (BT, Sky, TalkTalk and Virgin Media) had a major presence in a large number of exchanges across the UK.[41] These providers were deemed to be "Principal Operators" (POs). In this analysis, Vodafone was excluded from the list of POs due to its low national share of lines, despite having a relatively high (~60%) national coverage.

A4.41 Only BT is present at all exchanges, with the other POs present at a majority (but not all) exchanges. Based on the coverage of the POs, we estimated that across the whole country and weighting by premises served by each exchange, an 'average exchange' would have 3.3 POs present. We rounded this to the nearest whole number of operators per area, concluding that on average an exchange would have three operators present and hence used a 33% market share.[42]

A4.42 In the 2016 NMR Consultation we repeated this analysis with updated data on network coverage for these POs which produced an average of 3.4 operators per exchange. We also noted that Virgin Media had announced plans to roll out its cable network to approximately four million additional premises by 2020.[43] According to its press release, in 2015 Virgin had a network footprint covering roughly 50% of premises. This is planned to increase to roughly 60% of premises by 2020. Accounting for this planned rollout had the

[40] A similar wording is set out in the Explanatory Note to the 2009 EC Recommendation, Section 5.1.3.
[41] In this analysis, we considered two major factors: the national coverage of the operators, measured as the proportion of UK premises served by exchanges at which an operator has an unbundled presence; and the national share of lines, measured as the proportion of all fixed lines owned by a given telecoms provider across all exchanges.
[42] For further detail see the 2013 NMR Statement, paragraphs A6.88 to A6.104.
[43] Virgin Media 2015. *Virgin Media and Liberty Global announce largest investment in UK's internet infrastructure for more than a decade.* http://about.virginmedia.com/press-release/9467/virgin-media-and-liberty-global-announce-largest-investment-in-uks-internet-infrastructure-for-more-than-a-decade.

effect of slightly increasing the number of operators at an average exchange, bringing the total to 3.5.[44] This lay half-way between the assumptions of a 25% and a 33% market share. We wanted a round number of competitors in the fixed voice market in the long run, and proposed to round up to four operators on the basis that the PO analysis had not accounted for ISDN lines provided over non-BT wholesale connections (such as those provided over the Vodafone or KCOM networks). These operators were not considered POs, but we considered that they would have a material amount of voice traffic terminating on their infrastructure. We did not quantify the exact impact of including business ISDN lines in our analysis, but we expected this to add to the average number of operators in each exchange.

A4.43 We proposed to change the forward-looking market share assumption in a gradual manner over the period from 2013/14 to 2024/25.

A4.44 In its response to the 2016 NMR Consultation BT disagreed with our proposal to phase in the change in market share in a gradual manner.[45] It argued that we should use a 25% market share assumption in all years instead. It argued that the main reason for preferring four operators over three was the recognition that Vodafone should be considered a PO – a definitional change rather than a real change in the market. It also noted that it felt it was unrealistic to assume that a provider would manage its investment to perfectly fit a gradually-changing market share. Finally, BT noted that the gradual change in market share gave rise to an unusual modelling effect wherein both the constant 33% and 25% market share assumptions used as sensitivities each gave rise to a higher output FTR.

A4.45 We disagree with BT's characterisation of our analysis as being tipped due to including Vodafone as a PO in our analysis in the 2016 NMR Consultation where this was not the case in the 2013 NMR Statement. We decided not to include Vodafone as a PO in our analysis in the 2016 NMR Consultation. However, re-running the analysis with more recent data and accounting for Virgin Media's planned rollout (both of which reflect real developments in the market rather than simply definitional change) pushed the expected operators per exchange from 3.3 to 3.5. It was only when deciding whether to round this number up or down to the nearest integer number of POs that we considered the effect of ISDN infrastructure (including that operated by Vodafone).

A4.46 We have gathered data regarding ISDN lines provided by other providers and there are around 0.6m such lines. This is a material number of lines, enough that we consider rounding up to four operators to be more credible than rounding down to three operators.

A4.47 We agree with BT that trending the market share down implicitly assumes that the modelled operator is able to scale back its network with a great degree of precision. However, this is not unique to the issue of market share; there are many ways in which the model functions in a more precise manner than we would expect from any real-world

[44] We have since re-run this analysis on the latest available data from BT, and the result remains the same. There has been a very marginal increase in the expected number of operators per exchange, due to slight changes in the presence of POs at difference exchanges, but the overall result of the analysis remains the same with 3.5 POs per exchange.
[45] BT response to 2016 NMR Consultation, page 44.

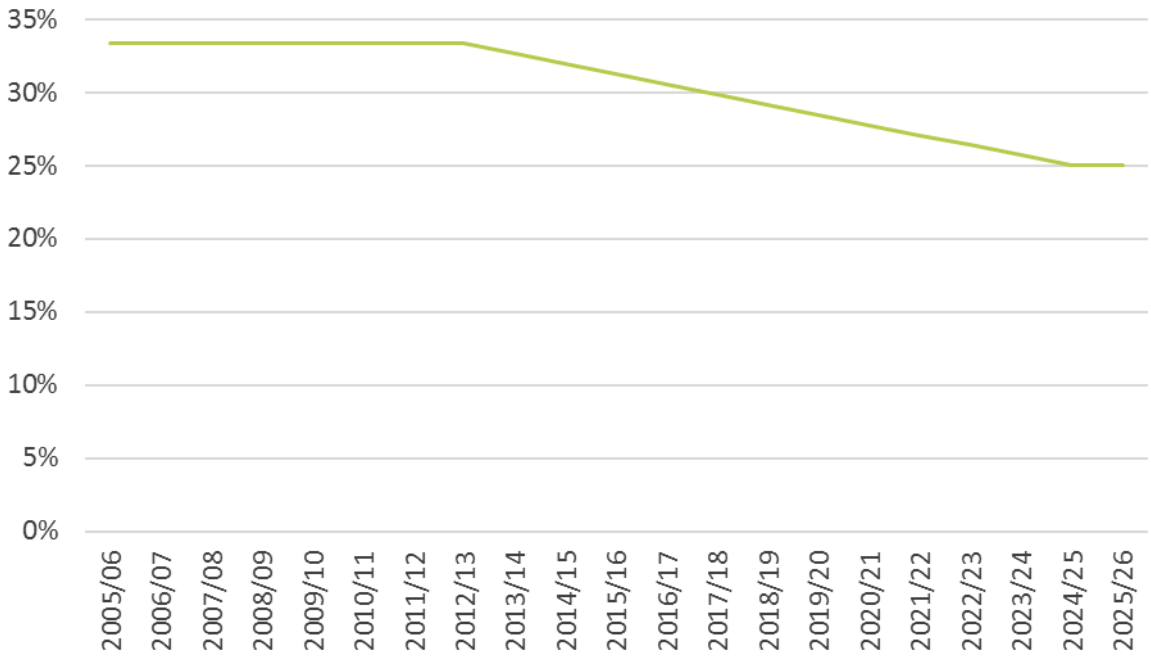
provider. For example, when dimensioning assets in the model even very small changes in volumes can lead to new assets being added to the network. What matters is that on average, over the long-run, the model reasonably mimics the evolution of an efficient network.

A4.48 The market share trend in the model is set up to model a transition between an initial period where the modelled provider has a 33% market share to a period where it has a 25% market share. While this transition could take place in many different ways, given that the change in our analysis is due to actual market developments and is not correcting an error in the 2013 analysis, we continue to believe that modelling a transition from 33% to 25% is an approach that better approximates reality than does BT's suggested alternative approach of assuming a 25% market share even in historical years where our analysis does not support this assumption.

A4.49 We do agree with BT that the 2016 WCT model produced an unintuitive result where the chosen market share assumption gave a lower FTR than both the low and high sensitivities. We believe this was due to the presence of modularity boundaries, as explained in Annex 9 of the 2016 NMR Consultation. This effect does not appear in the outputs of the 2017 WCT model. We discuss this further in Annex 5 of this document.

A4.50 On the basis of the above arguments, we have decided to continue with the market share assumption and phasing-in proposed in the 2016 NMR Consultation. The market share trend used in the 2017 WCT model is shown below in Figure A4.6.

Figure A4.6: Hypothetical operator market share[46]



Source: 2017 WCT model.

[46] The hypothetical operator's market share is held constant at 25% from 2024/25 for the remainder of the modelling period.

Network build

A4.51 In June 2012, we commissioned CSMG to develop network build and cost modules as part of the 2013 NMR. The network module takes the traffic forecasts from the demand module and dimensions a network to carry this traffic. We have reused the CSMG network modules in the 2017 WCT model.

A4.52 The 2017 WCT model assumes the operator builds an NGN in which multiple services are transported over a shared IP network. The model dimensions equipment to carry the network traffic based on various dimensioning parameters. The number of each of the elements required is based on up to three drivers: a minimum quantity and up to two drivers that determine how the element scales with demand.

A4.53 In the 2013 NCC model we included a capacity utilisation assumption of 70% for all network equipment. This means that when the traffic passed over a network element reaches 70% of the maximum possible for that element, a new element is deployed. We have not changed this assumption as it is consistent with data received from providers since the 2016 NMR Consultation. It applies to elements which are directly dimensioned by demand drivers. We consider that this is reflective of operators' real-world network planning approach to determining when capacity needs to be expanded.

A4.54 In its response to the 2016 NMR Consultation, BT argued that the model's assumption of an average busy hour call duration (BHCD) of 2.9 minutes was too high.[47] BT claimed that its data showed that the average BHCD during its network busy hour was 2.6 minutes. On this basis, BT argued that we should lower the input assumption in the model. We have requested data from providers (including BT) and have found that the BHCD varies from provider to provider. While BT's data show a shorter average BHCD, for other providers it is generally longer. The current model assumption of 2.9 minutes sits close to the middle of the range of BHCDs experienced by providers. We therefore have left this assumption unchanged in the 2017 WCT model.

A4.55 The model assumes there are 1.45 call attempts per successful call to account for unsuccessful calls (which implies that ~31% of calls are unsuccessful).

A4.56 Property costs are not modelled on a bottom-up basis. Instead, property costs are included with capital costs more generally by calculating an average capital cost per rack and applying this proportionately to the network equipment based on rack space occupancy. Opex for these items is estimated and applied in the same manner; as opex is calculated as a proportion of capex, the uplifted capex of assets to account for property costs will also uplift opex for those assets.

A4.57 Table A4.7 summarises the key network dimensioning parameters in the model. Except where noted above, we received no responses from providers relating to these parameters.

[47] BT response to 2016 NMR Consultation, page 46.

Table A4.7: Key network dimensioning parameters

	Description
Market share	33% prior to 2013/14, trending down to 25% by 2024/25
Capacity utilisation threshold[48]	70%
Voice busy hour	Occurs during the working day, 9% of daily voice traffic
Network busy hour	Occurs in the early evening, 8% of daily voice traffic, 9% of data traffic
Average call duration in the busy hour	2.9 minutes
Voice call requirement	Requires 135 kbps in each direction at the IP layer
Incoming: outgoing ratio[49]	31%

Source: 2017 WCT model.

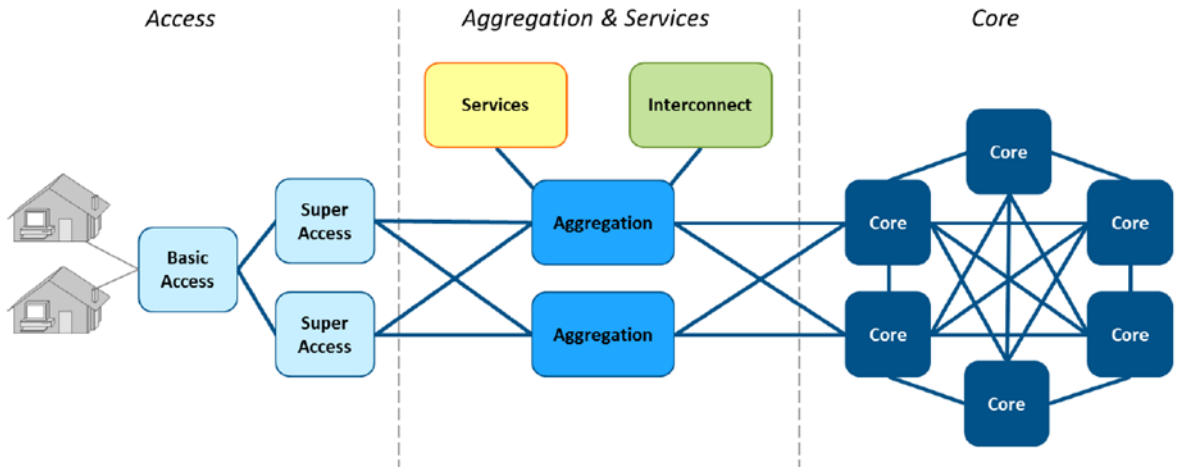
Node design

A4.58 The network module is based on a 'scorched-node' approach. This approach takes account of existing network topology. The 2017 WCT model uses the same location and serving area as the 2013 NCC model, which was based on the topology of BT's network exchanges. We have not updated the location and serving area data since 2013 because we believe any changes have been minor and hence would therefore have a minimal effect on the dimensioned network. We did not receive any consultation responses on this issue.

A4.59 Figure A4.8 provides an illustrative overview of the network architecture showing the relationship between the logical nodes.

[48] Applies to components which are dimensioned directly by demand drivers.
[49] This is a parameter that dimensions the amount of incoming traffic terminating on the network as a proportion of the outgoing traffic originated on the network. It was added to the model prior to publication in 2013 to fix an issue where the total traffic across the whole market was dependent on the market share assumption. We have maintained the use of this parameter in the 2017 WCT model.

Figure A4.8: NGN logical architecture



Source: CSMG, Annex 7 of the 2013 NMR Statement, page 6, Figure 2.

A4.60 The modelled NGN consists of a number of interconnected nodes. Access nodes are the physical locations which aggregate physical access connections from end-users. Each node includes a number of different pieces of network equipment and performs a specific function as follows:

- **Basic access node:** The basic access node is the node closest to the end-user at which the copper access lines terminate. There are approximately 4,000 basic access nodes.
- **Remote access node:** The remote access node is a specific kind of basic access node, serving remote and/or hard-to-reach locations. There are approximately 1,600 remote access nodes.
- **Super access node:** The super access nodes are co-located with the basic access node and aggregate traffic from basic access nodes before passing it on to the aggregation node. There are approximately 1,100 super access nodes.
- **Aggregation node:** The aggregation node aggregates traffic from the super access nodes and passes it on to the core node or to other provider networks via the interconnect nodes (see below). There are 106 aggregation nodes.
- **Interconnect node:** The interconnect node supports voice interconnection between the modelled NGN and other networks on an IP basis. As in the 2013 NCC model, we have decided to model a network with 20 Points of Interconnect (PoI)s.[50] These 20 PoIs are assumed to be co-located with the core nodes described below (which in turn are co-located with aggregation nodes).
- **Core node:** The core node transports traffic between aggregation nodes. There are 20 core nodes.
- **Service node:** The service nodes house the servers providing the service functionality, such as call servers, directory servers etc. There are two service nodes in the 2013 and 2016 models.

[50] Discussed in detail in 2013 NMR Statement, paragraphs A5.64 to A5.73.

Network cost

Cost of capital

A4.61 In the 2016 NMR Consultation we proposed to use the WACC for 'Other UK telecoms' as set out in the 2016 BCMR Statement of 9.8% (pre-tax nominal). We also proposed to switch from using RPI (as used in the 2013 NMR Statement) to CPI as the relevant measure of inflation, consistent with the change explained in Section 16.[51] Using a long-run CPI estimate of 2.0%, which is equal to the Bank of England's long-run inflation target, this resulted in a real WACC of 7.6%, which was used from 2016/17.

A4.62 In its consultation response TalkTalk argued that the WACC proposed in the 2016 NMR Consultation was too high. It said that the risk-free rate (RFR) had reduced since the 2016 BCMR Statement and that we should reassess the RFR and the WACC derived from it using a RFR of 0%.[52]

A4.63 The WACC consulted on in the 2017 WLA Consultation takes account of more recent evidence than that considered in the 2016 BCMR Statement, including yields on index-linked gilts which we use to inform our estimate of the real RFR. In the 2017 WLA Consultation we proposed to reduce the real RFR from 1.0% to 0.5%[53] and the proposed Other UK telecoms WACC was slightly lower than that used in the 2016 BCMR Statement. We have decided to use the more recent estimate of BT's WACC from the 2017 WLA Consultation as it takes account of more recent market conditions.

A4.64 The use of the Other UK telecoms WACC from the 2017 WLA Consultation also means that it takes account of the anticipated reduction in Corporation Tax from 19% to 17% from 1 April 2020.[54] We would prefer to avoid changing the WACC during the charge control period as this can cause step changes in the output FTR. However, maintaining a WACC set on the basis of a 19% corporation tax rate in perpetuity would lead to over-recovery of costs over the lifetime of the model, given the anticipated reduction in corporation tax rate from 2020 onwards. We have therefore decided to use the Other UK telecoms WACC based on a 19% corporation tax rate for the duration of the charge control period, and then used a 17% corporation tax rate for subsequent years.[55] This approach reflects the expected reduction in tax rate while maintaining stable FTRs.

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[51] This required us to recalculate the historical pre-tax WACC series using CPI. For this we used the pre-tax nominal WACC in previous NCC models and combined them with CPI inflation for the year in which each WACC was published, and maintained that figure over the duration for which that WACC is used. The use of a constant real WACC over a number of years helps to prevent instability in the economic depreciation algorithm (discussed later) and is consistent with the approach taken in the 2015 MCT Review.

[52] TalkTalk response to 2016 NMR Consultation, paragraph 6.5.

[53] Ofcom, March 2017. *Wholesale Local Access Market Review – Consultations on the proposed market, market power determinations and remedies*, Volume 2, paragraph A116.25. https://www.ofcom.org.uk/consultations-and-statements/category-1/wholesale-local-access-market-review. We proposed to slightly revise other parameters of the WACC as set out in Annex 16 of the 2017 WLA consultation.

[54] March 2017 WLA Consultation, Volume 2, paragraph A16.102.

[55] See March 2017 WLA Consultation, Volume 2, Table A16.34 where Other UK telecoms pre-tax nominal WACCs of 9.5% and 9.4% are shown reflecting the use of a 19% and 17% tax rate respectively.

A4.65 Consistent with this, we have used a pre-tax real WACC of 7.4% during the charge control period and 7.3% for the post-charge-control period. The time series of real WACC values used is shown in Table A4.9 below.

Table A4.9: Real (CPI) pre-tax WACC time-series[56]

	2005/06 to 2008/09	2009/10 to 2012/13	2013/14 to 2016/17	2017/18 to 2020/21	2021/22 and after	2005/06 to 2008/09[57]
Pre-tax real WACC	9.2%	7.0%	8.0%	7.4%	7.3%	9.2%

Source: Ofcom.

A4.66 We recognise that the 2017 WLA Consultation is not a final decision on the estimated WACC and has been open to stakeholder comments and further analysis. We do not wish to pre-empt the conclusion of any such further analysis and should the Other UK telecoms WACC change in the final WLA Statement then we will consider whether any adjustment is required to our charge control to account for the change.[58]

Cost trends

A4.67 The base year in the 2013 NCC model was 2012/13, with cost trends then applied to generate asset costs for the subsequent years. We have not explicitly updated the base year in the model for the present review; instead, we have updated the asset price trends as described below. This has the same effect as updating the base year without changing the overall structure of the model.

A4.68 In the 2016 NMR Consultation we explained that we had gathered evidence from providers and proposed to set price trends consistent with the 2013 NCC model adjusted for CPI, rather than RPI as was used in that model. The only exception was the cost trend for active equipment, which we proposed to reduce in 2013/14 from -5.2% to -9.0% per annum in real terms. As with the 2013 NCC model, we proposed that all cost trends in the model would be progressively flattened to zero over the period from 2016/17 to 2025/26. Starting in 2026/27 the real input trends would be held at 0% per annum as the model has reached the 'steady state'.

A4.69 In its response to the 2016 NMR Consultation, BT argued that this approach resulted in the active equipment cost trend being too volatile and suggested that instead we should use a

[56] Pre-tax nominal WACC estimates are taken from the August 2005 Ofcom approach to risk (for 05/06 to 08/09), the May 2009 Openreach financial framework (for 09/10 to 11/12), the March 2013 LLCC Statement (for 12/13 to 16/17) and the March 2017 WLA Consultation (for 17/18 onwards). Ofcom, 2005. *Ofcom's approach to risk in the assessment of the cost of capital.* https://www.ofcom.org.uk/__data/assets/pdf_file/0021/41970/final.pdf; Ofcom, 2009. *A new pricing framework for Openreach*. https://www.ofcom.org.uk/__data/assets/pdf_file/0012/46020/off.pdf; Ofcom, 2013. *Business Connectivity Market Review*. https://www.ofcom.org.uk/consultations-and-statements/category-2/business-connectivity-mr.

[57] From 2021/22, the WACC is held constant at 7.3% in pre-tax real terms in perpetuity.

[58] As shown in Annex 5 of this document, a change of ±1 percentage point in the WACC results in a change of around ±0.003ppm in the final termination rate.

constant -6% real cost trend for this equipment over the historical and forecast periods in order to avoid distortions from short-term price volatility.

A4.70 Since the consultation we have gathered further data from providers and have found that for active equipment the proposal in the 2016 NMR Consultation is no longer representative of the data available. Particularly when considering those elements that make up the majority of the costs affected by the active equipment cost trend, costs have fallen by less than 9% per annum (in real terms). On the basis of the data available to us we believe a more accurate estimate of the change in active equipment costs between 2013/14 and 2016/17 would be -5.2% (in real terms), in line with the CPI-adjusted 2013 NCC model assumptions. This also has the effect of reducing the volatility in the price trends and we believe this addresses BTs concerns regarding potential volatility in cost recovery.

A4.71 We continue to believe that cost trends should reach 0% in the steady state, so we have reduced the cost trend assumptions in the 2017/18-2020/21 period and again in the 2021/22-2025/26 period accordingly. The model uses seven categories of cost trends; the input assumptions for each of these during the 2013/14-2016/17, 2017/18-2020/21 and 2021/22-2025/26 periods are presented in Table A4.10 below.

Table A4.10: Real capex and opex cost trend model inputs, 2013/14 to 2025/26

	2013/14 to 2016/17	2017/18 to 2020/21	2021/22 to 2025/26
Property	-0.4%	0.0%	0.0%
Racks and cooling	-3.3%	-1.5%	-0.9%
Software and platforms	-4.3%	-2.5%	-1.5%
Active equipment	-5.2%	-3.5%	-2.5%
Passive equipment	-2.3%	-1.0%	-1.0%
Labour	+0.7%	+1.1%	+1.1%
Incremental admin costs	-28.8%[59]	-1.0%	-1.0%

Source: 2017 WCT model.

Note: all values presented in this table are annual changes in costs.

A4.72 For the period prior to 2013/14 we have maintained the cost trends for labour as used in the 2013 NCC model of +3.5% per annum in nominal terms (+1.1% in real terms). From 2013/14 to the steady state we have updated this trend to +3.1% in nominal terms on the basis of data from the OBR and ONS. This is the same assumption as was made in the 2017

[59] This large decline in incremental admin costs is explained later in this Annex.

WLA Consultation.[60] In real terms this is +0.7% for period 2013/14 to 2016/17 (using the average CPI inflation over the period of 2.4%) and, thereafter, +1.1% (using the forward-looking 2.0% CPI forecast).[61]

A4.73 As discussed in Section 16 and as we proposed in the 2016 NMR Consultation, we have decided to switch from using RPI to using CPI as the inflation index in the model. Due to the functioning of the economic depreciation algorithm described later in this annex, the cost recovery profile can be erratic when using fluctuating input price trends. In order to avoid this, we have used the geometric mean (2.4%) of the historical data so we have a single historical rate to maintain stability for cost recovery. The model assumes long-term forecast CPI inflation will be 2% p.a. in line with the Bank of England target.

Other modelled costs

A4.74 Installation costs are captured in the model through estimates of man-hours and labour rates. Equipment retirement costs have been included as part of capital expenditure. This cost to decommission each network element is based on the number of man hours required and the cost of labour.

A4.75 The capital costs of Operations and Business Support Systems (OSS/BSS) have been included. They have been modelled in the same way as in the 2013 NCC model, with a fixed cost component based on data received from information requests and including the cost of pre-launch feasibility tests.

A4.76 Excluding power, operating costs for each element are typically assumed to be 14% of the initial capex each year.[62]

A4.77 The cost of power per kWh is based on ONS data. We have forecast electricity prices to rise based on the trend of the past five years, at 3.3% per annum.

A4.78 The power usage assumptions and air conditioning requirements have not been updated from the 2013 NCC model. We assume that each kW required by network equipment produces heat that requires 0.8 kW of cooling. In the 2013 NCC model these assumptions were based on equipment vendor guidelines and responses to information requests and we believe that these assumptions remain reasonable for the current review period. We did not receive any consultation responses related to these assumptions.

[60] 2017 WLA Consultation, Volume 2, paragraph 4.18.
[61] OBR, March 2016. *Economic and Fiscal Outlook*. http://budgetresponsibility.org.uk/efo/economic-fiscal-outlook-march-2016/ [accessed 21 October 2017]; and ONS. *Change in Average Gross Weekly Earnings*. https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours [accessed 21 October 2017].
[62] Some specific assets have different opex percentages where the evidence we have collected from telecoms providers suggests this is appropriate.

Treatment of passive network elements

A4.79 We have not updated modelling of passive network assets. In the 2013 NCC model these were treated as common costs and contributed to the LRIC+ of WCT and WCO, but not the LRIC of WCT. We have maintained this approach for the 2017 WCT model.

Incremental administrative costs

A4.80 Prior to the 2013 NMR administration costs were charged for as a different service called PPP (Product management, Policy and Planning). Analysis from the February 2013 Consultation suggested that PPP costs were driven by factors other than the provision of wholesale call termination. Between 2007 and 2012 external WCT volumes fell by 22% even though PPP total costs increased by almost 10%.

A4.81 In response to the February 2013 Consultation BT provided a list of PPP activities which it suggested were incremental to WCT. These included:

- setting prices and issuing Network Charge Change Notices (NCCNs);
- the cost of volume measurement systems to identify where calls come from;
- maintenance of the Element Based Charging (EBC) matrix;
- maintenance of the price list and website; and
- processing of WCT invoicing.

A4.82 With further analysis, we determined that only maintenance of the EBC matrix was incremental to WCT. The EBC was used to identify at each of BT's switches which charge should be applied on a call-by-call basis. Without WCT, the EBC could be a much cheaper and simpler system and so we included part of the EBC costs (£3.5m) within the LRIC of WCT.

A4.83 Since then, we understand that BT has retired the EBC system and absorbed its functions into the A-Z Telephony Event Charging (AZTEC) system. We have sought data from BT prior to the 2016 NMR Consultation and again prior to this publication to assess whether the existing calculation of non-network incremental costs of WCT remains appropriate. We have not sought data from other providers as we understand that other major providers do not calculate charges on a call-by-call basis in the same way as BT; they instead choose to either simply apply the FTR at all nodes, or agree a blended rate to apply with other providers. While we acknowledge the cost savings in such an approach, we think it appropriate for providers to recover the efficient costs of call-by-call charging if they choose to charge in this manner.

A4.84 Having examined these costs, we proposed in the 2016 NMR Consultation that the assumption included in the 2013 NCC of £3.5m was no longer a reasonable estimate of the incremental non-network costs of WCT. We proposed a reasonable estimate of these costs for the review period to be £0.85m per annum. In light of further evidence provided by BT

that showed higher FTE and depreciation costs, we now believe the best estimate of these costs is £0.9mper annum.[63]

A4.85 We show a comparison of the EBC and AZTEC costs in Table A4.11 below. We have updated the model so that it uses the previous assumption of £3.5m in historical years, and trends down to the new assumption of £0.9m in 2016/17.

Table A4.11: Change in BT's incremental administrative costs

Activity	Cost (2013)	Cost (2017)
Main system (EBC / AZTEC)	[✂£]m	[✂£]m
Other systems	[✂£]m	[✂£]m
FTE	[✂£]m	[✂£]m
Depreciation	[✂£]m	[✂£]m
Total	[✂£]m	[✂£]m

Source: BT data gathered under s135.

A4.86 These costs are given a bespoke cost trend in the 2017 WCT model:

- Prior to 2013/14, they follow the same asset price trend as the OSS/BSS asset, in keeping with the approach taken in the 2013 NCC model;
- From 2013/14 these costs are trended down from £3.5m to reach £0.9m in 2016/17;
- From 2017/8 onwards, they are forecast to follow a real asset price trend of -1% per annum. The asset price trend represents the average reduction in cost expected of the asset every year. However, given the very large reduction seen recently, we do not expect such significant changes to be repeated or feasible. Instead, we have assumed that these costs would remain more stable over the forecast period.

Network build and cost module outputs

A4.87 The total annual capital and operating expenditure are calculated by multiplying the total element demand each year by the capex or opex for each unit of that element for each year.

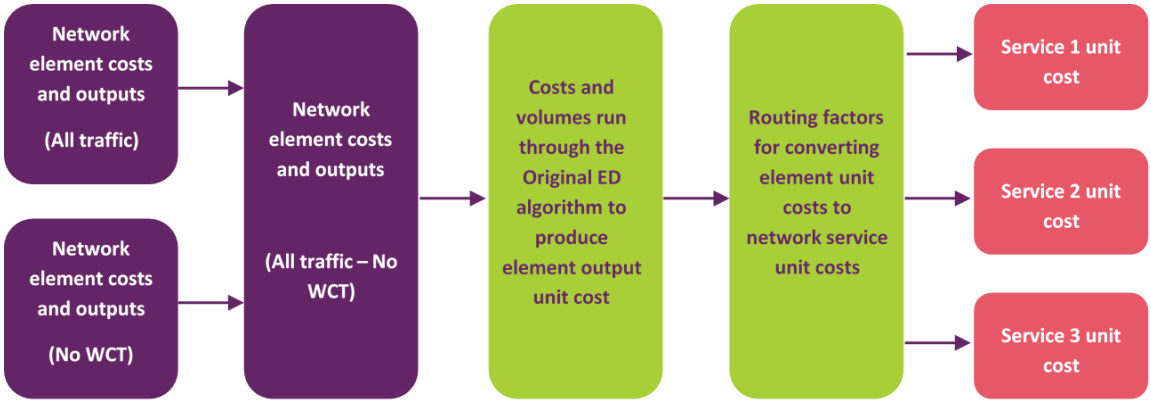
A4.88 The cost outputs provide inputs to the economic depreciation algorithm in the economic module. The routing factors from the network module are also used in the economic module to allocate the costs of network element output to network services.

[63] This number differs from that in Table A4.12 as we have rounded to a reasonable level of accuracy for this modelling assumption.

Depreciation and service costing

A4.89 Once the total costs of the hypothetical NGN have been established from the cost module, the economic module determines how these costs are recovered over time. An illustration of how costs are recovered both over time and across services is shown in Figure A4.12 below.

Figure A4.12: Cost recovery over time and across services[64]



Source: Ofcom.

A4.90 As for the 2013 NCC model, we consider that economic depreciation is more appropriate than accounting depreciation. Due to the inverse relationship between in-year utilisation and unit costs that usually results from accounting depreciation, we believe it is a less suitable option for calculating cost recovery. In our view, economic depreciation better reflects the forward-looking economic value of an asset. Using economic depreciation in bottom-up cost modelling is also consistent with the 2009 EC Recommendation, which states that:

"The recommended approach for asset depreciation is economic depreciation wherever feasible."[65]

A4.91 An alternative way to characterise economic depreciation is as a cash flow analysis to answer the question: what time series of prices, consistent with trends in the underlying costs of production and given forecast traffic, yield an expected present value equal to the capital and operating cash flows arising from building and running the network? In order to answer this question, Ofcom has previously used an approach to economic depreciation described as Original ED.[66] Original ED comprises the following three stages of calculation:

- **Stage 1:** A constant unit cost is calculated as if the final year utilisation and input costs applied over the entire lifetime of the network.

[64] The figure shows a three service model, relating to the three services that make up WCT: off-net incoming calls (passing over a single aggregation node), off-net incoming calls (passing across the core) and off-net incoming international calls. These three services are weighted by their respective volumes to produce a unit cost output for WCT.
[65] 2009 EC Recommendation, Recital (7).
[66] Original ED was developed as a depreciation approach by Oftel, see http://www.ofcom.org.uk/static/archive/oftel/publications/mobile/depr0901.htm. We also used this form of economic depreciation in the 2015 MCT cost model.

- **Stage 2:** A second component is added to recover the additional costs caused by earlier under-utilisation of the network compared to the final year level.[67] This step is also applied as a constant unit price for all years.
- **Stage 3:** A third component is added to recover the remaining un-recovered (or-over-recovered) costs due to input costs, including the WACC, being above (or below) the final year level. The shape of this component is determined by the arithmetic difference between in-year and final-year input costs (each scaled by the WACC in the relevant year), and is therefore zero in the final year (or any year that shares the same level of input costs and WACC as the final year).[68] More costs are recovered in years when asset prices and the WACC are higher than the final year.

A4.92 We have decided to continue to use Original ED to calculate cost recovery for the WCT charge control.

Verification of model outputs

A4.93 When we developed the 2013 NCC model we identified that we would not be able to calibrate the model because there were no fully national NGN operators present in the UK. Rather than calibrate the 2013 NCC model, we identified two ways to verify the way the model recovered costs:

- First, the model should not recover more costs in historical periods than was possible given the regulated charges prevailing at the time; and
- Second, the modelled unit cost estimates for the regulated services combined should be no lower over the period to 2016/17 than the unit costs of a heavily depreciated TDM network.

A4.94 The first of these tests was particularly important in the 2013 NMR as we had changed the modelling approach to depreciation from accounting depreciation to economic depreciation. Accounting depreciation usually involves taking the price that would be paid for equipment and dividing this value by the expected equipment life to reach a depreciation charge for that year. An economic approach to depreciation considers costs over the entire economic life of the network and attempts to match the profile of cost recovery of an asset to the profile of its utilisation.

A4.95 In the 2016 NMR Consultation we proposed to continue with this approach to model verification, and did not receive any responses on this. Below we present the historical model outputs and discuss the implications for model specification.

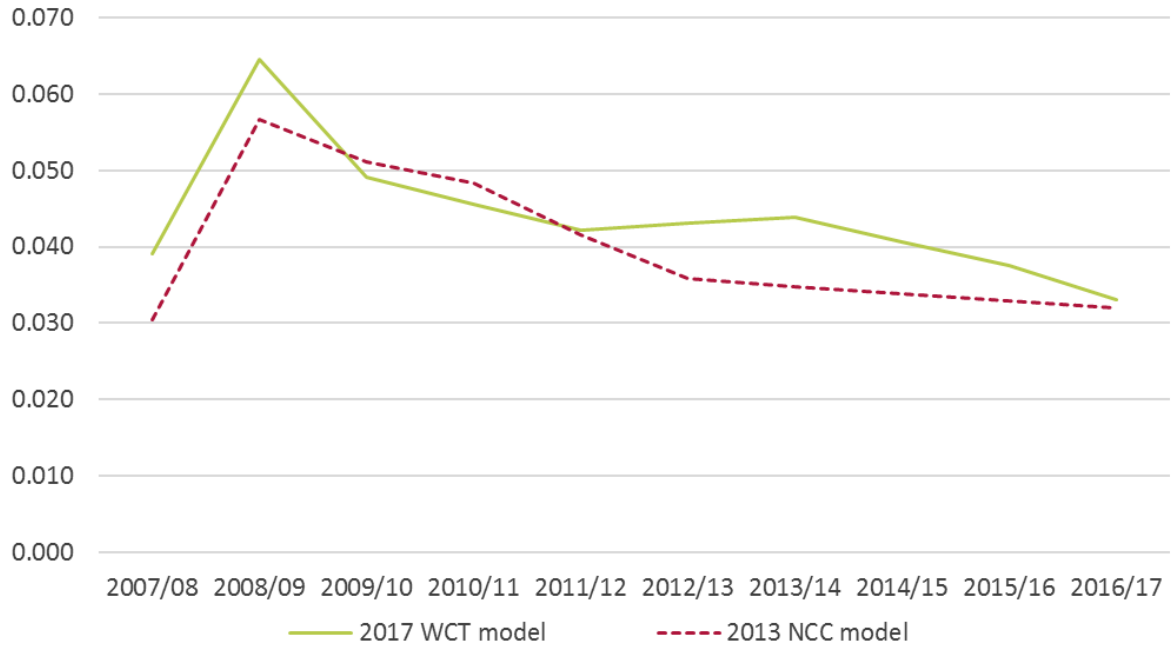
Historical cost recovery

A4.96 Figure A4.13 below compares the WCT LRIC outputs of the 2013 NCC and 2017 WCT models for the previous charge control period. It shows that the current model produces a

[67] If utilisation is decreasing, then this could be a negative value.
[68] The "input costs" for a particular year are the asset price (or operating cost) for that year and the WACC. The arithmetic difference between in-year and final year input cost can be written as (Asset pricet x WACCt) – (Asset pricen x WACCn). Where (t) is the current year and (n) is the final year.

higher LRIC FTR between 2012/13 to 2016/17 than was produced by the 2013 NCC model, although this was not the case for all historic periods.

Figure A4.13: WCT LRIC outputs of the 2013 and 2017 models, in real 2012/13 terms



Source: 2017 WCT model.

A4.97 On the basis of the first cost-verification approach described in the 2013 NMR statement, this result could imply that an adjustment to the model for the future path of cost-recovery was necessary. However, having reflected further on the implications of such an adjustment we do not propose adjusting the model for the following two reasons:

a) First, only adjusting the model for historic under-recovery introduces an upwards bias in expected cost-recovery meaning that there would not be a 'fair bet'. Because of the way that the ED algorithm functions, any parameter changes will increase or decrease cost recovery in all modelled years, rather than only in forecast years. This means that almost any parameter change in the model will have implications for historical cost recovery by either increasing or decreasing the amount of costs to be recovered historically. We would not expect to reduce the forecast FTR were the model to produce a historic cost recovery profile lower than the profile of regulated rates (i.e. the reverse of situation in the chart above[69]).

b) Second, WCT is only one side of a two-sided market, the other side being call and line services provided to wholesale or retail customers. Even if we were to make an adjustment to address an apparent cost-under-recovery historically, since we wish to

[69] This aim of taking a consistent approach to cost over- or under-recovery in the context of a model of economic depreciation aligns with that described in the 2011 MCT review. Ofcom, 2011. *Wholesale mobile voice call* termination, Annex 6, paragraph A6.232. https://www.ofcom.org.uk/__data/assets/pdf_file/0026/53981/mct_statement_annex_6-10.pdf.

maintain a LRIC-cap on WCT, any mark-up would fall to WCO (under the previous modelling approach).[70] However, we are no longer charge controlling WCO or WFAEL and BT's current margins across these two services are above FAC (all the more so when we consider returns on ISDN2 and ISDN30 – see Section 6 above). Other terminating providers are unregulated in their provision of call origination and line services (either at the retail or the wholesale level) and we have imposed a symmetric cap at LRIC on all fixed line providers with SMP in WCT.

Comparison to future TDM costs

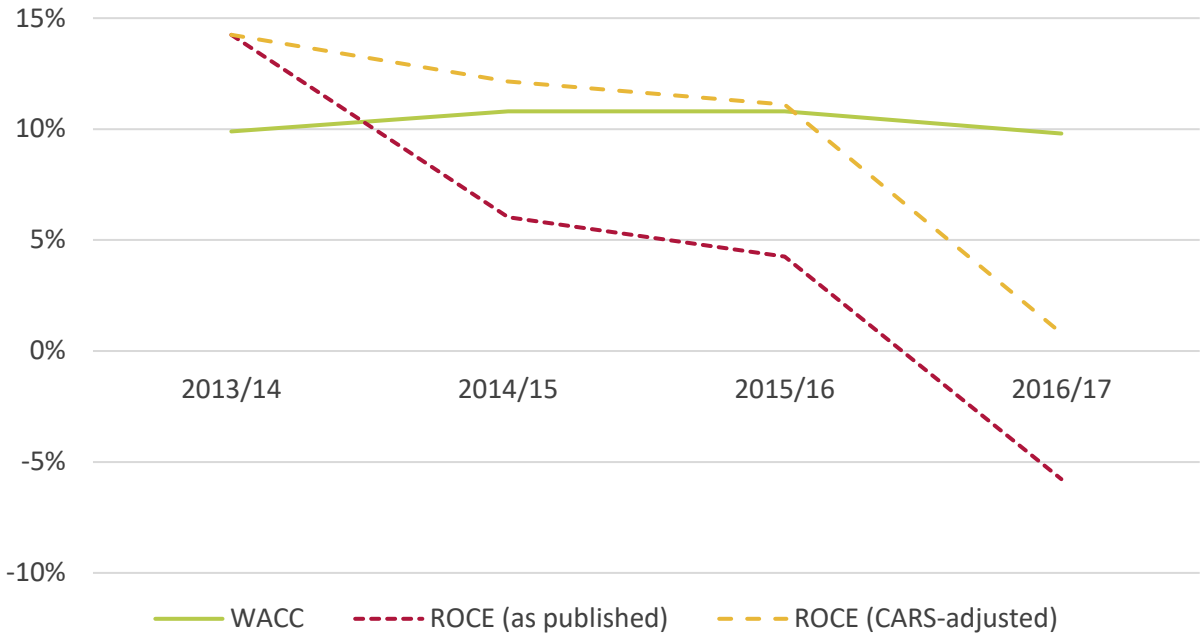
A4.98 Due to a lack of reliable data regarding TDM costs, it is difficult to undertake the second cost verification made in 2013 in a robust manner. However, the 2017 WCT model is a modified version of the 2013 NCC model which did produce forecast unit costs (then over the period 2013/14 to 2016/17) that were above those of a depreciated TDM network, then based on a comparison from extending the 2009 NCC model. Since that model is now many years out of date and it is unclear what an efficient TDM network would now look like, we have used BT's returns as a proxy for this exercise. As a result, we have only looked at the returns over the last review period (which were capped based on an NGN model much like the 2017 WCT model), rather than look at a projection comparing NGN model outputs with forecast depreciated TDM model outputs.

A4.99 Figure A4.14 below illustrates the path of BT's ROCE for WCO and WCT combined, which has decreased from above WACC in 2013/14 to around zero in 2016/17. Some of this reduction follows from the reduction in volumes of WCO and WCT, although much of it is also due to the impact of the CAR adjustments made in the 2015/16 RFS which allocated additional operating costs and MCE to narrowband services compared to previous years.[71]

A4.100 However, the charge controls on WCO and WCT were set before the CAR adjustments were made, and therefore do not account for them. The same is true of the charge controls in other markets prior to 2016, and so the apparent shortfall in the ROCE for WCO and WCT is made up for by a commensurate increase in the ROCE in other markets where costs have been removed. We have therefore adjusted BT's returns and MCE to remove the impact of the CAR adjustments from 2014/15 onwards in the chart below.[72]

[70] The calculation of this mark-up is explained in the 2013 NMR Statement, paragraphs A6.174-A6.175. The reallocation of mark-up costs from WCT to WCO is explained in paragraphs 8.68 to 8.70.
[71] According to BT the effect of the CARs adjustments on narrowband services in 2015/16 was to increase operating costs by £18m and MCE by £27m.
[72] We have adjusted BT's ROCE by removing £27m of MCE and £18m of operating costs in each year since 2014/15, as we do not have detailed information regarding the exact impact of CAR on origination and termination costs in each year.

Figure A4.14: ROCE vs. WACC for termination and origination combined



Source: BT's RFS data, 2015 LLCC Consultation and 2017 WLA Consultation 'other UK telecoms' WACC.

A4.101 After adjusting for the impact of the CAR adjustments, BT's returns were above its WACC across WCO and WCT combined from 2013/14 to 2015/16. There was a sharp drop in ROCE in 2016/17 bringing returns below WACC even after being adjusted. However, the three years of over-recovery broadly offset the single year of under-recovery in 2016/17.

A4.102 We have investigated why the 2016/17 returns were so much lower than in previous years, and it appears to be primarily due to an increase in the operating costs of WCO in this year; whereas other costs of WCO have decreased between 2015/16 and 2016/17 broadly in line with the volume decline over this period. Rising operating costs despite falling volumes could be a signal that we are approaching the end of the period in which TDM costs can continue to be considered efficient. We will continue to monitor BT's TDM network costs for WCO and WCT with a view to using them to form part of any future assessment of the efficiency of NGN and TDM networks (e.g. in the next Narrowband Market Review).

Conclusion on model output verification

A4.103 The 2017 WCT model is an extension of the 2013 NCC model with limited revisions to the modelling assumptions. Within the limits of the data available, we have sought to replicate similar analysis for the 2017 WCT model. Whilst an update of the first model cross-check suggests that the future cost outputs could be uplifted, such an approach implies departing from the efficient bottom-up LRIC of WCT. Further, and on reflection, we prefer not to make such an adjustment, since if there had been implied cost over-recovery we would not propose to amend the future path of regulated prices. Instead, we prefer to set a path of prices consistent with the future efficient LRIC of WCT, and not to adjust the model.

A4.104 In relation to a comparison against future efficient TDM network costs, we consider that this is an increasingly difficult exercise, given the increasing age of such networks. However, we note that WCT is part of a two-sided market with no provider (including BT) now price regulated in relation to the other-side of the market, i.e. call origination or access lines (i.e. WFAEL[73]).

Other responses to the 2016 NMR Consultation

A4.105 We received some further comments relating to the modelling of FTRs that were not specific to any individual part of the model. These are addressed below.

Benchmark with other EU rates

A4.106 BT argued in its response that the output FTR presented in the 2016 NMR Consultation was out of line with estimates in other EU countries.[74] It argued that we should explain why it is credible that our proposed LRIC was outside the range of all other EU nations.

A4.107 We disagree with BT that a detailed explanation is required if the projected FTR lies outside the range of other EU countries' FTRs. The rate we have calculated is cost-based by reference to an NGN using cost and volume data from the major fixed providers in the UK. There are many reasons why NRAs may calculate different FTRs. First, some NRAs may simply adopt a benchmarking approach rather than undertake cost modelling. Second, differences in LRIC may reflect differences in the geographies, population densities, network traffic, network topologies and other market features in the various EU countries.

A4.108 With a general downward trend in rates we would expect future calculated rates to be lower on average than rates calculated previously, particularly if other NRAs follow the 2009 EC Recommendation – i.e. use a bottom-up LRIC model based on an NGN.

Choice of parameters

A4.109 BT argued in its response that it appeared Ofcom had specifically chosen parameter inputs in order to achieve a minimum LRIC.[75] To support this view it noted that certain parameter inputs led to increased LRIC in both the low and high sensitivity analysis presented in Annex 9 of the 2016 NMR Consultation. BT argued that we should set an FTR higher in the range of sensitivities to address this issue.

A4.110 We did not deliberately select parameter inputs to minimise the output from the 2016 WCT model. As explained in Annex 9 of the consultation, the modelled traffic in the base case sat close to a modularity threshold for key incremental network elements, which meant that parameter changes that affected the modelled traffic had, in some cases, asymmetric effects. Scenarios involving higher volumes, which would ordinarily result in reduced unit costs, crossed this modularity threshold which added additional cost to the

[73] While BT will be price regulated in wholesale ISDN2 and ISDN30 lines, accounting returns in those two markets are well above WACC and are expected to remain so over the control period (i.e. to 2020/21), see Section 6.
[74] BT response to 2016 NMR Consultation, paragraphs A1.34-A1.37.
[75] BT response to 2016 NMR Consultation, paragraph A1.8.

model that outweighed the reduction in unit costs from spreading costs over greater volumes. We do not think that it would be appropriate to manually adjust the base case output in order to sit it more centrally in the range of sensitivities chosen.

A4.111 In any case, as we set out in Annex 5 to this document, the effect reported by BT is no longer the case in the 2017 WCT model. This is not due to any deliberate change to the approach on parameter values, but rather due to the updated volume forecasts meaning that the model does not sit so near modularity thresholds.

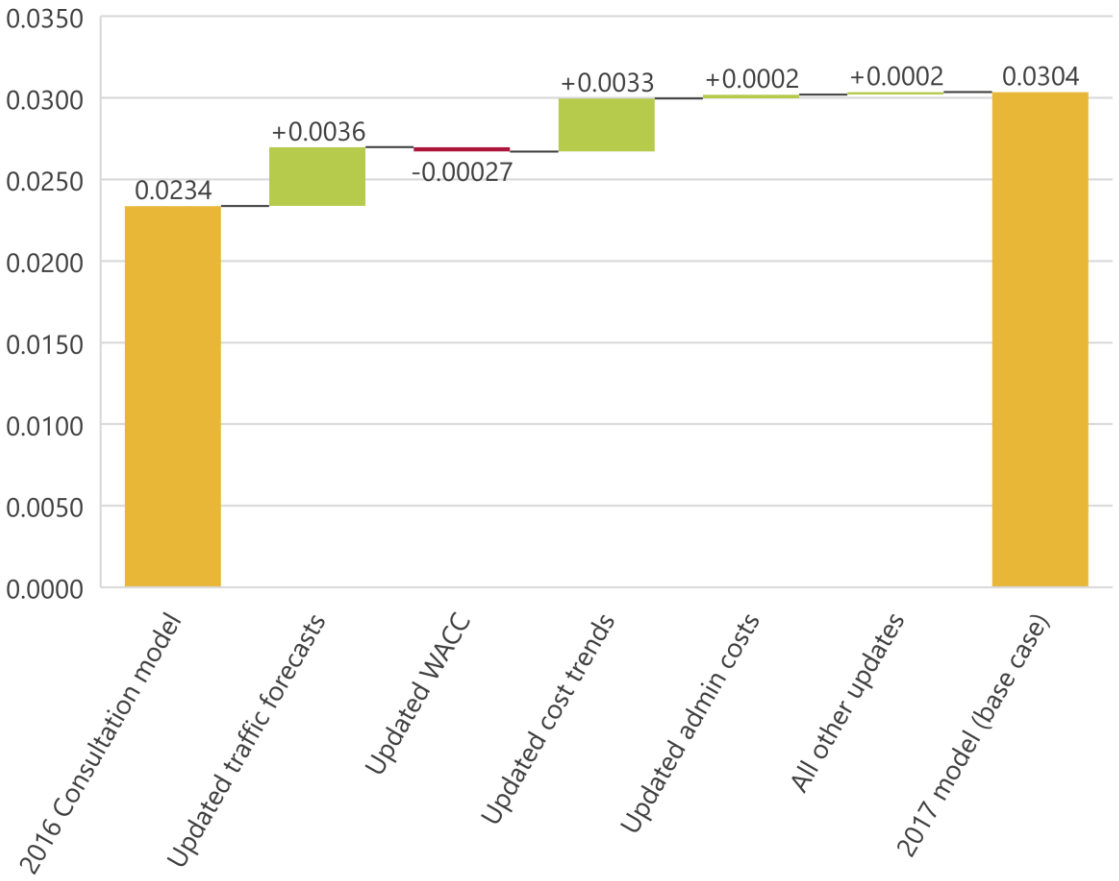
Summary of base case output and changes since the 2013 NCC model

A4.112 For illustrative purposes, we have presented the main changes between the FTR outputs of the 2013 NCC model and the 2017 WCT model. These are presented in Figure A4.15 below. The drivers of change shown are the updated traffic forecasts, WACC, cost trends, admin costs and other minor modelling updates (e.g. minor modelling error corrections).

A4.113 As a result, the real (CPI deflated) LRIC of WCT for 2018/19 is lower than projected in 2013 by around 7% (i.e. around 0.002ppm). This amounts to a cumulative reduction in revenue of around £4m over the duration, or about 4p per year per line on average, compared with holding the current rate constant in nominal terms.[76]

[76] This is based on assuming 37.0bn minutes of net incoming traffic per year based on data from 2016 (33.7bn minutes of mobile-to-fixed traffic and ~3.3bn minutes of incoming international traffic) and 33.5m exchange lines per year. Data are taken from the quarterly telecoms data tables.

Figure A4.15: Waterfall chart of changes to the modelled LRIC of WCT for 2017/18, ppm in real 2016/17 prices



Note: The value for the 2016 Consultation model differs from the 0.024ppm presented in the 2016 Consultation document. This is due to differences in the charge control period proposed in the 2016 Consultation and that used in this document. We have updated the 2016 Consultation model to produce outputs consistent with the period used in this document, which has the effect of slightly lowering the output rate.

Note: The 2017 model base case output is the financial year output of the model and therefore differs slightly from the values presented in Tables 1.6 and 16.2 which include an adjustment to show 2018/19 outputs covering the period 1 February 2018 to 31 March 2019. This adjustment is specific to the functioning of the charge control and is not relevant to the overall functioning of the 2017 WCT model depicted here.

A5. WCT cost model sensitivity analysis

A5.1 As explained in Annex 4 we have calculated the LRIC of WCT using the 2017 WCT model and used this to inform our charge control. This annex presents the sensitivity of the results of the model to changes in key inputs and combines these to create low cost and high cost scenarios. Please note that the values presented in this annex are the financial year outputs of the model and therefore differ slightly from the values presented in Tables 1.6 and 16.2, which include an adjustment to show 2018/19 outputs covering the period 1 February 2018 to 31 March 2019. This adjustment is specific to the functioning of the charge control and is not relevant to the overall functioning of the 2017 WCT model depicted here.

Model results for the base case

A5.2 The 2017 WCT model base case uses the following assumptions:

- an operator with 20 points of interconnect (PoI);
- one voice server node (with a second for resilience);[77]
- NGN services start to be offered in 2008/09 with full migration lasting four years;
- the medium demand forecast remains the selected forecast used in line and usage per line assumptions;
- the assumed market share for the efficient operator starts at 33% and trends down to reach 25% in the steady state;
- WACC is set at a real pre-tax rate of 7.4% over the charge control period and 7.3% thereafter;[78] and
- costs are calculated in real terms for 2012/13 prices and presented in real terms for 2016/17 prices using historic CPI inflation data. Results are presented for the first year of the charge control, 2018/19.

Sensitivity analysis: demand assumptions

A5.3 This section examines the impact of changes in demand parameters on the model's outputs. The four demand sensitivities are:

- **Voice traffic:** high, medium and low values for all voice traffic inputs;
- **Data traffic:** high, medium and low values for the number of broadband lines and peak bandwidth use;
- **Market share:** assumptions of a constant 25%, a trend down from 33% to 25%, and a constant 33% market share (with all other assumptions held at the base case scenario level); and
- **All traffic:** high, medium and low values for voice traffic, data traffic, and market share.

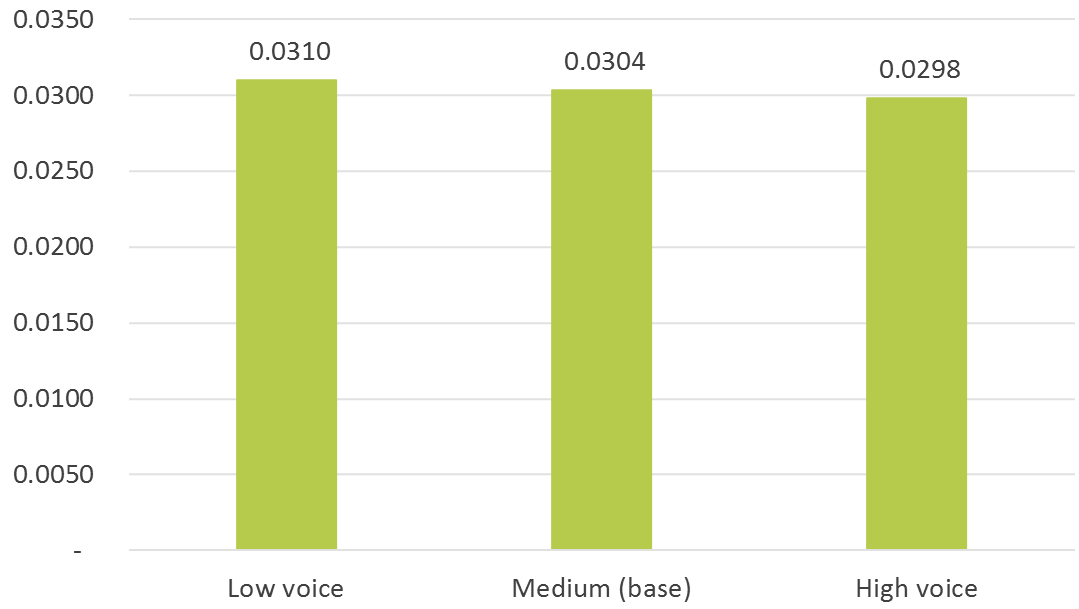
[77] In order to maintain resilience, the voice server nodes are doubled and so an input of one voice server node equates to two voice server nodes being built.
[78] The historic WACC is taken as given and not flexed in the sensitivity analysis.

A5.4 In the 2016 NMR Consultation we noted that various parameter changes had an unintuitive result wherein both the low and high sensitivities resulted in an increased cost over the base case. This was due to the model crossing modularity boundaries for key equipment. This issue is not as prevalent in the 2017 WCT model, with all sensitivities producing generally intuitive results.

Voice traffic and lines

A5.5 Figure A5.1 below shows the impact on the unit LRIC of WCT (in 2016/17 pence per minute) from adjusting the volume of voice traffic and number of lines.

Figure A5.1: Model sensitivity to changes in voice traffic and lines, 2018/19 LRIC in 2016/17 prices (ppm)



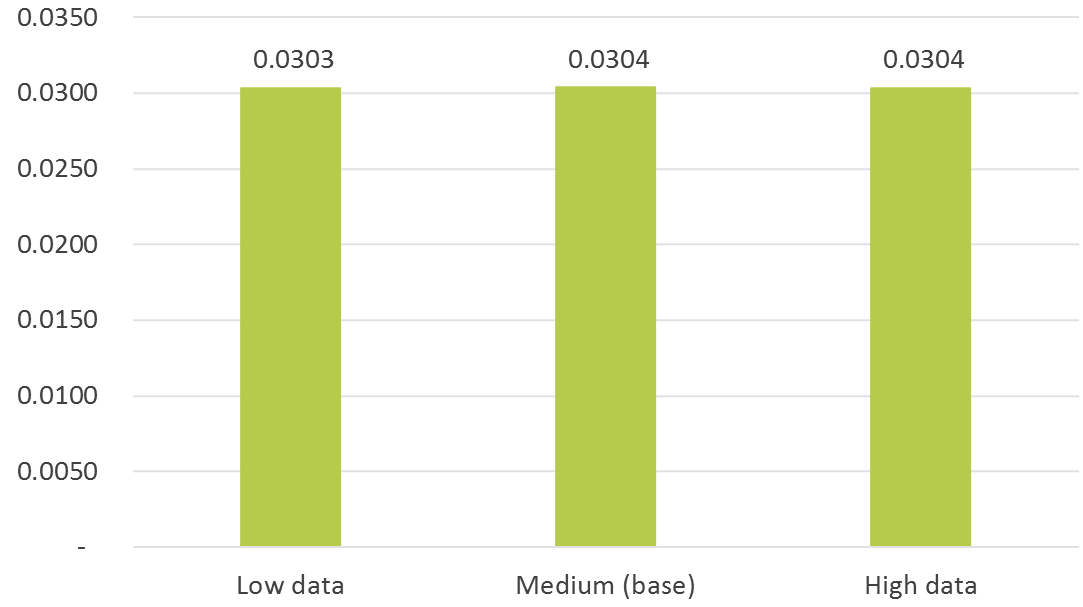
Source: 2017 WCT model.

A5.6 The model responds to this change as we would expect, with higher voice traffic and line volumes slightly reducing the output LRIC FTR, as costs generally increase more slowly than volumes due to the presence of fixed costs, and vice versa.

Data traffic and broadband lines

A5.7 Figure A5.2 below shows the impact of changing assumptions about peak broadband usage and the number of broadband lines on the unit LRIC of WCT.

Figure A5.2: Model sensitivity to changes in data traffic and broadband lines, 2018/19 LRIC in in 2016/17 prices (ppm)



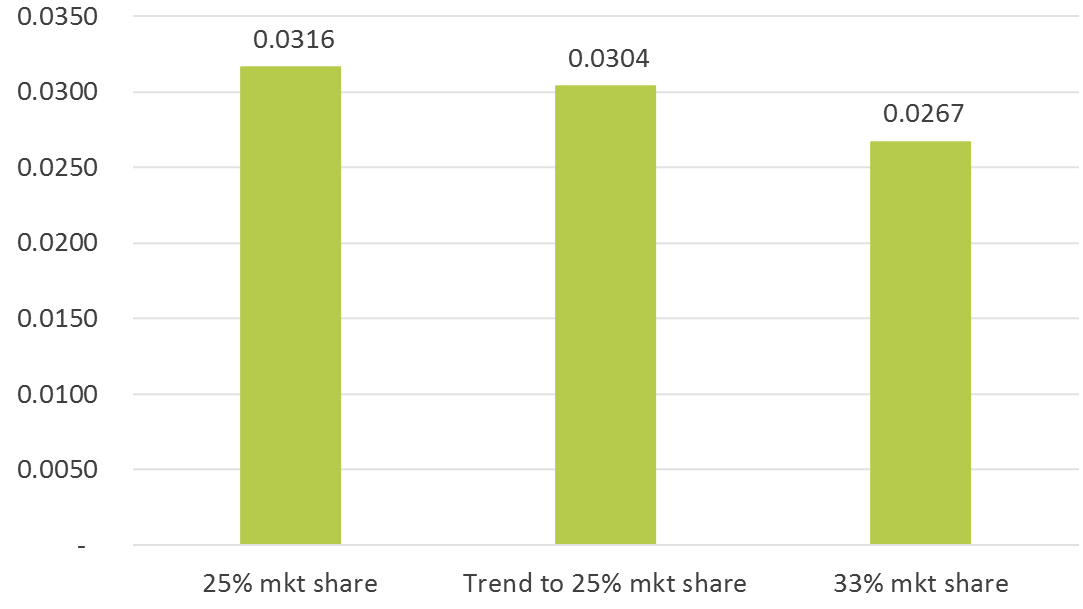
Source: 2017 WCT model.

A5.8 The unit LRIC of WCT from the model is almost entirely insensitive to changes in data traffic and broadband lines.

Market share

A5.9 Figure A5.3 below shows the change in the unit LRIC of WCT resulting from changes in the market share assumption.

Figure A5.3: Model sensitivity to changes in market share, 2018/19 LRIC in 2016/17 prices (ppm)



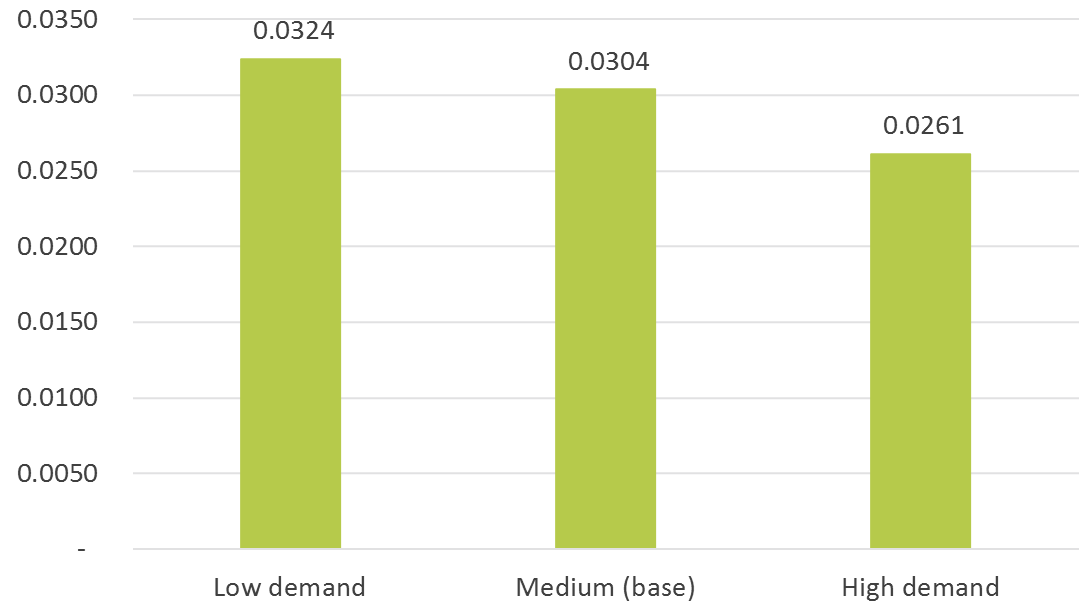
Source: 2017 WCT model.

A5.10 In general, we would expect that as market share increases, the unit LRIC of WCT would decrease due to the presence of fixed costs (i.e. for the same reasons discussed above relating to voice call volumes). This is what we have found in our sensitivity analysis.

Combination of multiple demand assumption

A5.11 The effect of changing the main demand parameters together is displayed in Figure A5.4 below.

Figure A5.4: Model sensitivity to changes in all demand parameters, 2018/19 LRIC in 2016/17 prices (ppm)



Source: 2017 WCT model.

A5.12 The combination of the key demand parameters results in a higher LRIC in the low-demand scenario and a lower LRIC in the high-demand scenario, as we would expect. The dominant effect appears to be the change in market share, as the results are very similar to the outputs of just changing the market share assumption.

Sensitivity analysis: network and input cost assumptions

A5.13 In this section we discuss the impact of variation in a number of non-demand related assumptions. The seven network and input cost assumptions are:

- **Speed of network deployment:** the modelled network rolls out over four or six years;
- **Start of network roll-out:** the modelled network is deployed from 2005/06, 2007/08 or 2012/13;
- **Number of POI:** 20, 30 or 100 POI;
- **Asset utilisation:** assets in the model are planned to run at 65%, 70% or 75% utilisation;
- **WACC:** the cost of capital is assumed to be 6.6%, 7.6% or 8.6%;

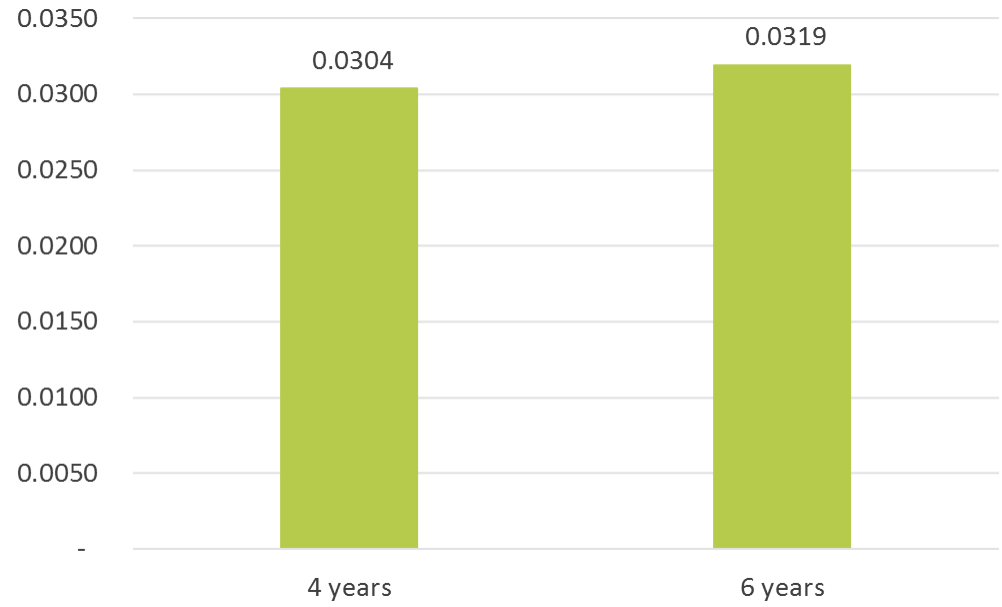
- **Incremental admin costs:** these costs are assumed to be £650k, £850k or £1.05m; and

A5.14 **Busy hour call length:** Calls in the busy hour assumed to last on average 2.2, 2.9 or 3.8 minutes.

Speed of network deployment

A5.15 In the model base case we assume that deployment of the NGN begins in 2007/08 and lasts for four years. Figure A5.5 shows the impact of changing the deployment period on the model's outputs. Increasing the deployment duration increases the unit LRIC of WCT.

Figure A5.5: Model sensitivity to changes in network deployment period, 2018/19 LRIC in 2016/17 prices (ppm)

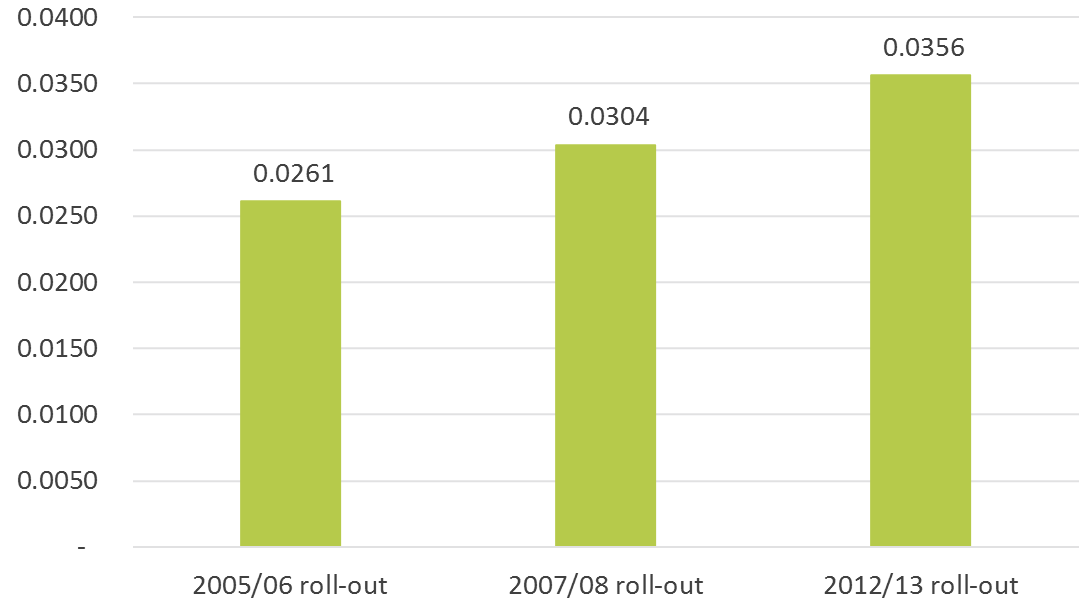


Source: 2017 WCT model.

Start of network roll-out

A5.16 The model base case begins network deployment in 2007/08. The impact of changing the date of deployment is shown in Figure A5.6. In each of these cases the deployment period is held constant at the base case assumption of four years.

Figure A5.6: Model sensitivity to changes in network deployment date, 2018/19 LRIC in 2016/17 prices (ppm)



Source: 2017 WCT model.

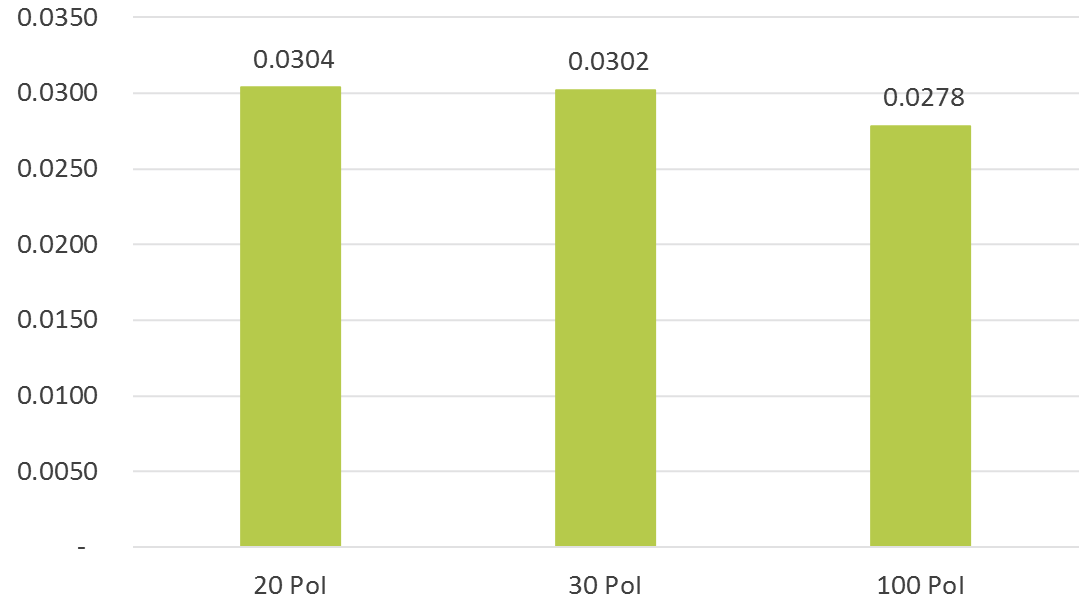
A5.17 The sensitivity of the WCT unit cost when we move the start date is due to two factors:

- First, due to declining volumes, delaying the rollout of the network means that over the modelling period the network carries lower average volumes per year and therefore generally unit costs are higher in each year, and vice versa with an earlier deployment.
- Second, due to the way Original ED recovers the costs of assets over time, and the way the network is deployed. By moving the deployment start date later we delay the first year of cost recovery, which is the point at which input costs are highest. Costs trend down from this maximum point to the terminal unit cost. Therefore, the charge control period occurs at a higher point on this downward trend the later the network deployment rate, and vice versa with an earlier deployment.

Number of points of interconnect

A5.18 Figure A5.7 below shows the sensitivity of the model to changes in the number of PoI. The model assumes 20 PoI in the base case. Changing the number of PoIs does not have a consistent impact on the unit LRIC of WCT. This is to be expected as increasing the number of PoI will increase the amount of interconnection assets required (which increases network costs), but decrease the amount of assets required for carrying the call around the network (which reduces network costs). The overall effect on the unit LRIC of WCT therefore depends on the extent to which these effects offset.

Figure A5.7: Model sensitivity to changes in number of points of interconnection, 2018/19 LRIC in 2016/17 prices (ppm)

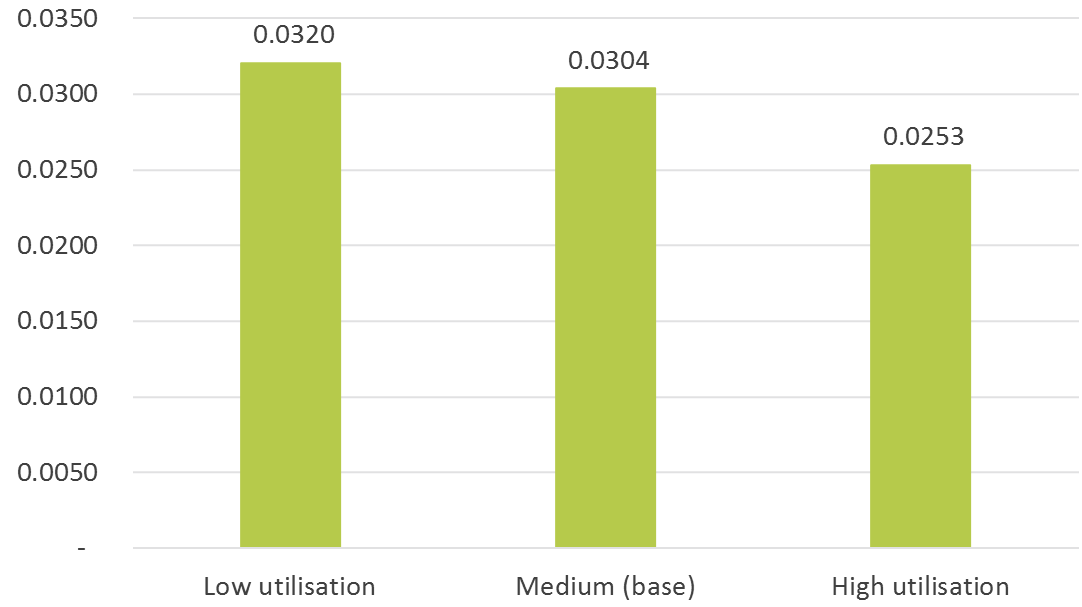


Source: 2017 WCT model.

Asset utilisation

A5.19 Figure A5.8 below shows the sensitivity of the model to changes in the asset utilisation. The asset utilisation rate in the model is assumed to be 70% in the base case, with high and low sensitivities of 75% and 65% respectively.

Figure A5.8: Model sensitivity to changes in asset utilisation, 2018/19 LRIC in 2016/17 prices (ppm)



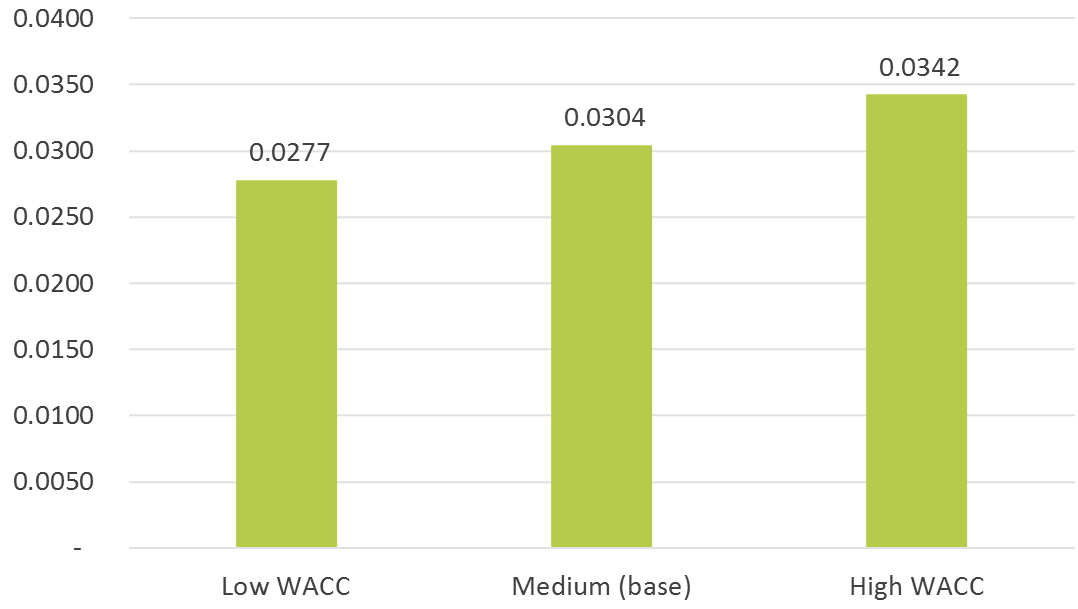
Source: 2017 WCT model.

A5.20 Increasing the utilisation rate reduces the unit LRIC of WCT estimate as fewer assets are required to provide a given set of volumes, because each asset can carry higher volumes before an additional asset is deployed. The reverse is true for decreasing the utilisation rate, as we would expect. The difference in output LRIC of WCT is asymmetric, with reducing utilisation having a smaller impact on the FTR than increasing it. This is due to how the modelled demand sits relative to modularity thresholds.

WACC

A5.21 Figure A5.9 below shows the model's sensitivity to changes in the WACC assumption which is 7.4% in pre-tax real terms (CPI adjusted) during the charge control period and then 7.3% thereafter, as explained in Annex 4. We then apply a sensitivity adjustment of ±1 percentage point to each of these assumptions in the low and high cases.

Figure A5.9: Model sensitivity to changes in the pre-tax real WACC, 2018/19 LRIC in 2016/17 prices (ppm)



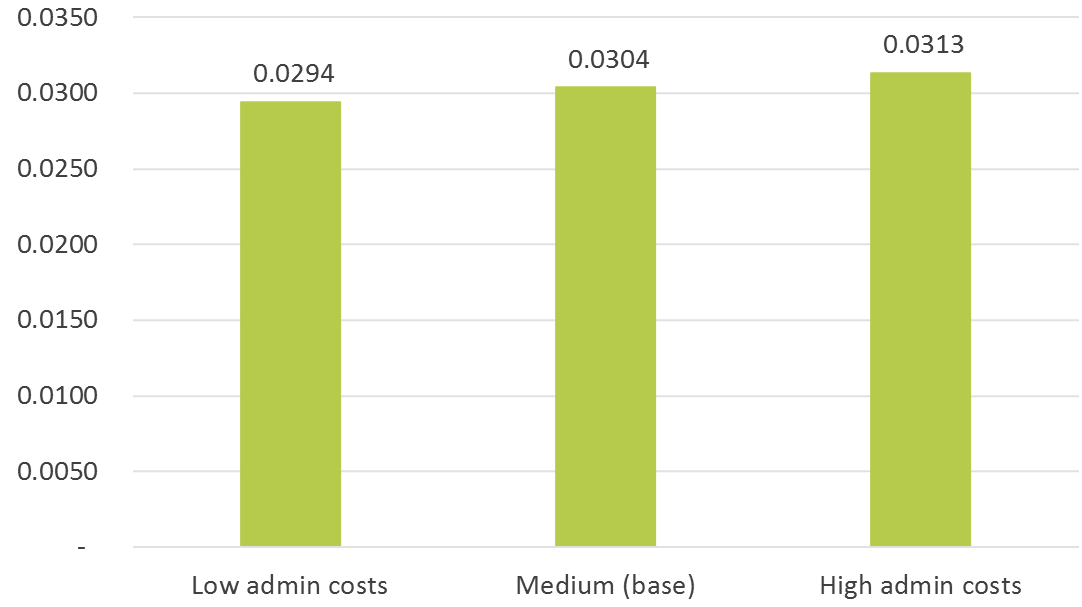
Source: 2017 WCT model.

A5.22 The model outputs are as we would expect, with an increase in the WACC increasing the amount of cost to be recovered through the unit LRIC of WCT.

Incremental admin costs

A5.23 Figure A5.10 below shows the model's sensitivity to changes in the assumption of incremental admin costs which are £900,000 in the base case in 2016/17. We then apply a sensitivity adjustment of ±£200,000 to this assumption.

Figure A5.10: Model sensitivity to changes in incremental admin costs, 2018/19 LRIC in 2016/17 prices (ppm)



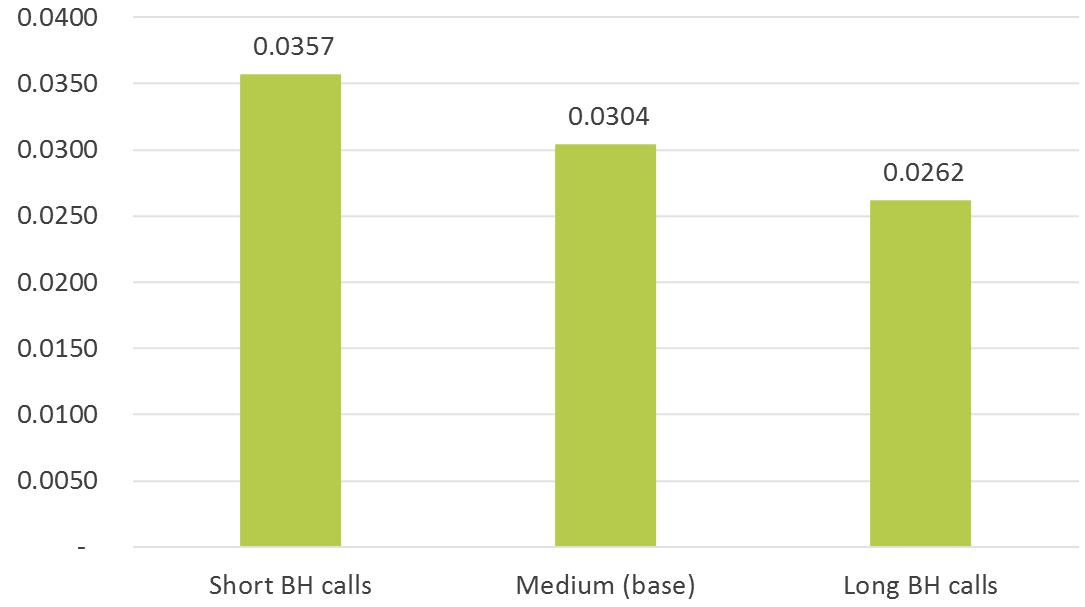
Source: 2017 WCT model.

A5.24 The model is relatively insensitive to changes in the incremental admin costs of the scale that we have tested. Spread across all volumes, changes of £200,000 have only a small effect on the unit LRIC of WCT.

Busy hour call length

A5.25 Figure A5.11 below shows the sensitivity of results to changes in the average call length of calls in the busy hour. The model assumes calls in the busy hour last 2.9 minutes, with high and low sensitivities of 3.6 minutes and 2.2 minutes respectively.

Figure A5.11: Model sensitivity to changes in busy hour (BH) call length, 2018/19 LRIC in 2016/17 prices (ppm)



Source: 2017 WCT model.

A5.26 The model is relatively sensitive to changing the busy hour call length, as it is a key dimensioning parameter driving the number of assets required in the network. This assumption determines how the fixed volumes across the network are divided into individual calls, with a shorter busy hour call length meaning that there are more individual calls made on the network. Setting up calls is a key dimensioning variable for certain incremental assets, such as call servers. Therefore, a shorter busy hour call length means more of these assets are required, and the unit cost of WCT is higher. The reverse is true for longer call lengths.

Base case, high cost and low cost scenarios

A5.27 In order to produce a range of possible values, we have calculated the LRIC of WCT in combined high cost and low cost scenarios. Each scenario represents a combined set of input assumptions. These are illustrated in Table A5.12 below.

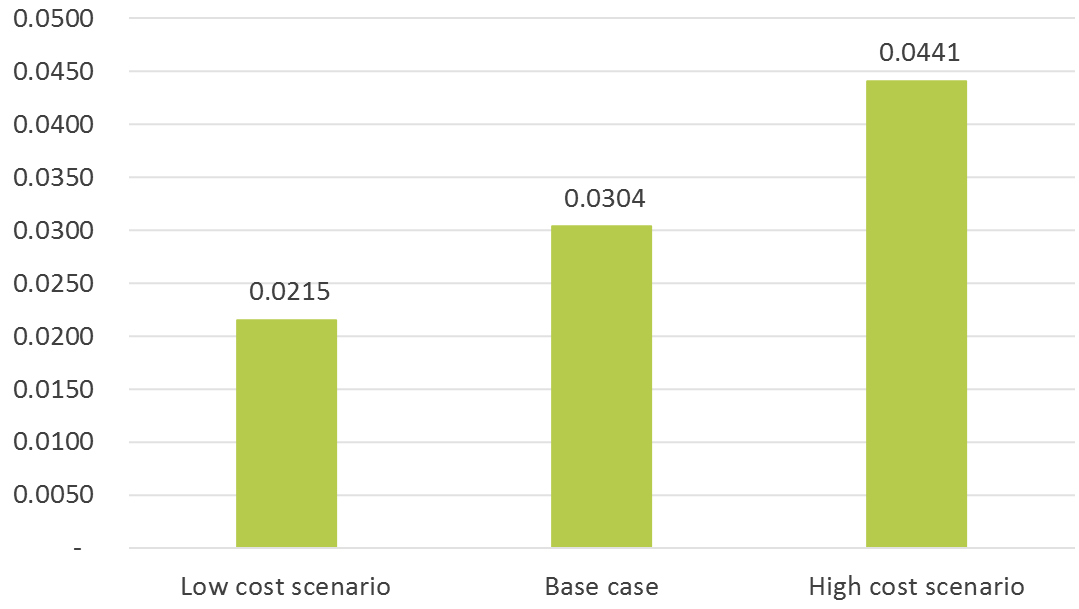
Table A5.12: Summary of assumptions for the three scenarios

	Base case	High cost scenario	Low cost scenario
Demand	Medium	Low	High
Market share	33% trend to 25%	25%	33%
Network element utilisation	70%	65%	75%
Busy hour call length	2.9 mins	2.2 mins	3.6 mins
Incremental admin costs	£900,000	£1,100,000	£700,000
WACC	7.4% / 7.3%	8.4% / 8.3%	6.4% / 6.3%

Source: Ofcom.

A5.28 The resulting unit LRIC of WCT for each one of the three scenarios can be seen in Figure A5.13 below. The resulting range for LRIC in 2018/19 is quite wide with the high cost scenario producing a LIRC around twice that of the low cost scenario. However, we consider that the probability of the high cost and low cost scenarios is quite low because in each scenario the model is taking a combination of extreme values for the key input assumptions.

Figure A5.13: Wholesale call termination LRIC scenarios, for 2018/18 in 2016/17 prices (ppm)



Source: 2017 WCT model.

A6. Regulatory framework

A6.1 This annex provides an overview of the market review process to give some additional context to the matters discussed in this Statement, including the draft legal instruments published at Annexes 9 and 10.

A6.2 Market review regulation is technical and complex, and requires us to apply legislation and take into account a number of relevant recommendations and guidelines. This overview identifies some of the key aspects of materials relevant to this market review, but does not purport to give a full and exhaustive account of all materials that we have considered in reaching our proposals on this market.

Market review concept

A6.3 A market review is a process by which, at regular intervals, we identify relevant markets appropriate to national circumstances and carry out analyses of these markets to determine whether they are effectively competitive. Where an operator has significant market power (SMP) in a market, we impose appropriate remedies, known as SMP obligations or conditions, to address this. We explain the concept of SMP below.

A6.4 In carrying out this work, we act in our capacity as the sector-specific regulator for the UK communications industries, including telecommunications. Our functions in this regard are to be found in Part 2 of the Act.[79] We exercise those functions within the framework harmonised across the European Union for the regulation of electronic communications by the Member States (known as the CRF), as transposed by the Act. The applicable rules[80] are contained in a package of five EC Directives, of which two Directives are particularly relevant for present purposes, namely:

- Directive 2002/21/EC on a common regulatory framework for electronic communications networks and services (the Framework Directive); and
- Directive 2002/19/EC on access to, and interconnection of, electronic communications networks and associated facilities (the Access Directive).

A6.5 The Directives require that NRAs (such as Ofcom) carry out reviews of competition in communications markets to ensure that SMP regulation remains appropriate and proportionate in the light of changing market conditions.

A6.6 Each market review normally involves three analytical stages, namely:

- the identification and definition of the relevant markets (the market definition procedure);

[79] http://www.legislation.gov.uk/ukpga/2003/21/contents
[80] The Directives were subsequently amended on 19 December 2009. The amendments have been transposed into the national legislation and applied with effect from 26 May 2011 and any references in this document to the Act should be read accordingly.

- the assessment of competition in each market, in particular whether the relevant market is effectively competitive (the market analysis procedure); and
- the assessment of appropriate regulatory obligations (the remedies procedure).

A6.7 These stages are normally carried out together.

Market definition procedure

A6.8 The Act provides that, before making a market power determination[81], we must identify *"the markets which in [our] opinion, are the ones which in the circumstances of the United Kingdom are the markets in relation to which it is appropriate to consider whether to make such a determination"* and analyse those markets.

A6.9 The Framework Directive requires that NRAs shall, taking the utmost account of the 2014 EC Recommendation[82] and SMP Guidelines[83] published by the EC, define the relevant markets appropriate to national circumstances, in particular relevant geographic markets within their territory, in accordance with the principles of competition law.

A6.10 The 2014 EC Recommendation identifies a set of product and service markets within the electronic communications sector in which *ex ante* regulation may be warranted. Its purpose is twofold. First, it seeks to achieve harmonisation across the single market by ensuring that the same markets will be subject to a market analysis in all Member States. Second, the 2014 EC Recommendation seeks to provide legal certainty by making market players aware in advance of the markets to be analysed.

A6.11 However, NRAs are able to regulate markets that differ from those identified in the 2014 EC Recommendation where this is justified by national circumstances by demonstrating that three cumulative criteria referred to in the 2014 EC Recommendation (the three-criteria test) are satisfied and where the EC does not raise any objections.

A6.12 The three criteria, which are cumulative, are:

- the presence of high and non-transitory structural, legal or regulatory barriers to entry;
- a market structure which does not tend towards effective competition within the relevant time horizon, having regard to the state of infrastructure-based and other competition behind the barriers to entry; and

[81] The market power determination concept is used in the Act to refer to a determination that a person has SMP in an identified services market.
[82] EC, *Commission Recommendation of 9 October 2014 on relevant product and service markets within the electronic communications sector susceptible to ex ante regulation in accordance with Directive 2002/21/EC of the European Parliament and of the Council on a common regulatory framework for electronic communications networks and services*, (2014/710/EU), http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014H0710&from=EN
[83] EC, *Commission guidelines on market analysis and the assessment of significant market power under the Community regulatory framework for electronic communications networks and services* (2002/C 165/03), 11 July 2002, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2002:165:0006:0031:EN:PDF

- competition law alone is insufficient to adequately address the identified market failure(s).

A6.13 The fact that an NRA identifies the product and service markets listed in the 2014 EC Recommendation or identifies other product and service markets that meet the three-criteria test does not automatically mean that regulation is warranted. Market definition is not an end in itself but rather a means of assessing effective competition.

A6.14 The relationship between the market definitions identified in this review and those listed in the 2014 EC Recommendation is discussed in relevant parts of this Statement.[84]

A6.15 The SMP Guidelines make clear that market definition is not a mechanical or abstract process. It requires an analysis of any available evidence of past market behaviour and an overall understanding of the mechanics of a given market sector. As market analysis has to be forward-looking, the SMP Guidelines state that NRAs should determine whether the market is prospectively competitive, and thus whether any lack of effective competition is durable, by taking into account expected or foreseeable market developments over the course of a reasonable period.[85] The SMP Guidelines clarify that NRAs enjoy discretionary powers which reflect the complexity of all the relevant factors that must be assessed (economic, factual and legal) when identifying the relevant market and assessing whether an undertaking has SMP.

A6.16 The SMP Guidelines also describe how competition law methodologies may be used by NRAs in their analysis. In particular, there are two dimensions to the definition of a relevant market: the relevant products to be included in the same market and the geographic extent of the market. Ofcom's approach to market definition follows that used by the UK competition authorities, which is in line with the approach adopted by the EC.

A6.17 While competition law methodologies are used in identifying the relevant markets *ex ante*, the markets identified will not necessarily be identical to markets defined in *ex post* competition law cases, especially as the markets identified *ex ante* are based on an overall forward-looking assessment of the structure and the functioning of the market under examination. Accordingly, the economic analysis carried out for the purpose of this review, including the markets we have identified, is without prejudice to any analysis that may be carried out in relation to any investigation pursuant to the Competition Act 1998[86] (relating to the application of the Chapter I or II prohibitions or Article 101 or 102 of the Treaty on the Functioning of the European Union[87]) or the Enterprise Act 2002.[88]

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[84] See, in particular, where we set out how we consider the three criteria test is cumulatively satisfied for each of the relevant markets which are not included in the 2014 EC Recommendation, but for which we have concluded are markets in which *ex ante* regulation is warranted.
[85] The SMP Guidelines provide that the actual period used should reflect the specific characteristics of the market and the expected timing for the next review of the relevant market by the NRA.
[86] http://www.legislation.gov.uk/ukpga/1998/41/contents
[87] Previously Article 81 and Article 82 of the EC Treaty, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2010:083:FULL:EN:PDF.
[88] http://www.legislation.gov.uk/ukpga/2002/40/contents

Market analysis procedure

Effective competition

A6.18 The Act requires that we carry out market analyses of identified markets for the purpose of making or reviewing market power determinations. Such analyses are normally to be carried out within two years from the adoption of a revised recommendation on markets, where that recommendation identifies a market not previously notified to the EC, or within three years from the publication of a previous market power determination relating to that market. Exceptionally, the three-year period may be extended for up to three additional years where the NRA notifies the EC, and it does not object.

A6.19 In carrying out a market analysis, the key issue for an NRA is to determine whether the market in question is effectively competitive. The 27th recital to the Framework Directive clarifies the meaning of that concept:

> "[it] is essential that *ex ante* regulatory obligations should only be imposed where there is not effective competition, i.e. in markets where there are one or more undertakings with significant market power, and where national and Community competition law remedies are not sufficient to address the problem".

A6.20 The definition of SMP is equivalent to the concept of dominance as defined in competition law. In essence, it means that an undertaking in the relevant market is in a position of economic strength affording it the power to behave to an appreciable extent independently of competitors, customers, and ultimately consumers. The Framework Directive requires that NRAs must carry out their market analysis taking the utmost account of the SMP Guidelines, which emphasise that NRAs should undertake a thorough and overall analysis of the economic characteristics of the relevant market before coming to a conclusion as to the existence of SMP.

A6.21 In that regard, the SMP Guidelines set out, additionally to market shares, a number of criteria that can be used by NRAs to measure the power of an undertaking to behave to an appreciable extent independently of its competitors, customers and consumers, including:

- the overall size of the undertaking;
- control of infrastructure not easily duplicated;
- technological advantages or superiority;
- absence of or low countervailing buying power;
- easy or privileged access to capital markets/financial resources;
- product/services diversification (e.g. bundled products or services);
- economies of scale;
- economies of scope;
- vertical integration;

- highly developed distribution and sales network;
- absence of potential competition; and
- barriers to expansion.[89]

A6.22 A dominant position can derive from a combination of these criteria, which when taken separately may not necessarily be determinative.

Sufficiency of competition law

A6.23 As part of our overall forward-looking analysis, we also assess whether competition law by itself (without *ex ante* regulation) is sufficient, within the relevant markets we have defined, to address the competition problems we have identified. Aside from the need to address this issue as part of the three-criteria test, we also consider this matter in our assessment of the appropriate remedies which, as explained below, are based on the nature of the specific competition problems we identify within the relevant markets as defined. We also note that the SMP Guidelines clarify that, if NRAs designate undertakings as having SMP, they must impose on them one or more regulatory obligations.

A6.24 In considering this matter, we bear in mind the specific characteristics of the relevant markets we have defined. Generally, the case for *ex ante* regulation is based on the existence of market failures which, by themselves or in combination, mean that the establishment of effective competition might not be possible if the regulator relied solely on *ex post* competition law powers which are not specifically tailored to the sector. Therefore, it may be appropriate for *ex ante* regulation to be used to address such market failures along with any entry barriers that might otherwise prevent effective competition from becoming established within the relevant markets we have defined. By imposing *ex ante* regulation that promotes competition, it may be possible to reduce such regulation over time as markets become more competitive, allowing greater reliance on *ex post* competition law.

A6.25 *Ex post* competition law is also unlikely in itself to bring about (or promote) effective competition, as it prohibits the abuse of dominance rather than the holding of a dominant position itself. In contrast, *ex ante* regulation is normally aimed at actively promoting the development of competition through attempting to reduce the level of market power (or dominance) in the identified relevant markets, thereby encouraging the establishment of effective competition.

A6.26 We generally take the view that *ex ante* regulation provides additional legal certainty for the market under review and may also better enable us to intervene in a timely manner. We may also consider that certain obligations are needed as competition law would not remedy the particular market failure, or that the specific clarity and detail of the obligation is required to achieve a particular result.

[89] SMP Guidelines, paragraph 78.

Remedies procedure

Powers and legal tests

A6.27 The Framework Directive prescribes what regulatory action NRAs must take depending upon whether or not an identified relevant market has been found effectively competitive. Where a market has been found effectively competitive, NRAs are not allowed to impose SMP obligations and must withdraw such obligations where they already exist. On the other hand, where the market is found not effectively competitive, the NRAs must identify the undertakings with SMP in that market and then impose appropriate obligations.

A6.28 NRAs have a suite of regulatory tools at their disposal, as reflected in the Act and the Access Directive. Specifically, the Access Directive specifies a number of SMP obligations, including transparency, non-discrimination, accounting separation, access to and use of specific network elements and facilities, price control and cost accounting. When imposing a specific obligation, the NRA will need to demonstrate that the obligation in question is based on the nature of the problem identified, proportionate and justified in the light of the policy objectives as set out in Article 8 of the Framework Directive.

A6.29 Specifically, for each and every SMP obligation, we explain why it satisfies the requirement in section 47(2) of the Act that the obligation is:

- objectively justifiable in relation to the networks, services, facilities, apparatus or directories to which it relates;
- not such so as to discriminate unduly against particular persons or against a particular description of persons;
- proportionate to what the condition or modification is intended to achieve; and
- transparent in relation to what is intended to be achieved.

A6.30 Additional legal requirements may also need to be satisfied depending on the SMP obligation in question. For example, in the case of price controls, the NRA's market analysis must indicate that the lack of effective competition means that the CP concerned may sustain prices at an excessively high level or may apply a price squeeze to the detriment of end-users and that the setting of the obligation is appropriate for the purposes of promoting efficiency, promoting sustainable competition and conferring the greatest possible benefits on the end-users of public electronic communications services. In that instance, NRAs must take into account the investment made by the CP and allow it a reasonable rate of return on adequate capital employed, taking into account any risks specific to a particular new investment, as well as ensure that any cost recovery mechanism or pricing methodology that is mandated serves to promote efficiency and sustainable competition and maximise consumer benefits. Where an obligation to provide third parties with network access is considered appropriate, NRAs must take into account factors including the feasibility of the network access, the technical and economic viability

of creating networks[90] that would make the network access unnecessary, the investment of the network operator who is required to provide access[91], and the need to secure effective competition[92] in the long term.

A6.31 To the extent relevant to this review, we demonstrate the application of these requirements to the SMP obligations in question in the relevant parts of this document. In doing so, we also set our assessment of how, in our opinion, the performance of our general duties under section 3 of the Act is secured or furthered by our regulatory intervention, and that it is in accordance with the six Community requirements in section 4 of the Act. This is also relevant to our assessment of the likely impact of implementing our conclusions.

Ofcom's general duties – section 3 of the Act

A6.32 Under the Act, our principal duty in carrying out functions is to further the interests of citizens in relation to communications matters and to further the interests of consumers in relevant markets, where appropriate by promoting competition.

A6.33 In doing so, we are required to secure a number of specific objectives and to have regard to a number of matters set out in section 3 of the Act.

A6.34 In performing our duties, we are also required to have regard to a range of other considerations, as appear to us to be relevant in the circumstances. For the purpose of the NMR, we consider that a number of such considerations are relevant, in particular:

- the desirability of promoting competition in relevant markets; and
- the desirability of encouraging investment and innovation in relevant markets.

A6.35 We have also had regard to the principles under which regulatory activities should be transparent, accountable, proportionate, consistent, and targeted only at cases in which action is needed, as well as in the interest of consumers in respect of choice, price, quality of service and value for money.

A6.36 Ofcom has, however, a wide measure of discretion in balancing its statutory duties and objectives. In doing so, we take account of all relevant considerations, including responses received during our consultation process, in reaching our conclusions.

European Community requirements for regulation – sections 4 and 4A of the Act and Article 3 of the BEREC Regulation

A6.37 As noted above, our functions exercised in this review fall under the CRF. As such, section 4 of the Act requires us to act in accordance with the six European Community requirements for regulation. In summary, these six requirements are:

[90] Including the viability of other network access products, whether provided by the dominant provider or another person.
[91] Taking account of any public investment made.
[92] Including, where it appears to us to be appropriate, economically efficient infrastructure-based competition.

- to promote competition in the provision of electronic communications networks and services, associated facilities and the supply of directories;
- to contribute to the development of the European internal market;
- to promote the interests of all persons who are citizens of the EU;
- to take account of the desirability of Ofcom's carrying out of its functions in a manner which, so far as practicable, does not favour one form of or means of providing electronic communications networks, services or associated facilities over another (i.e. to be technologically neutral);
- to encourage, to such extent as Ofcom considers appropriate for certain prescribed purposes, the provision of network access and service interoperability, namely securing efficient and sustainable competition, efficient investment and innovation, and the maximum benefit for customers of CPs; and
- to encourage compliance with certain standards in order to facilitate service interoperability and secure freedom of choice for the customers of CPs.

A6.38 We consider that the first, third, fourth and fifth of those requirements are of particular relevance to the matters under review and that no conflict arises in this regard with those specific objectives in section 3 of the Act that we consider are particularly relevant in this context.

A6.39 Section 4A of the Act requires Ofcom, in carrying out certain of its functions (including, among others, Ofcom's functions in relation to market reviews under the CRF) to take due account of applicable recommendations issued by the EC under Article 19(1) of the Framework Directive. Where we decide not to follow such a recommendation, we must notify the EC of that decision and the reasons for it.

A6.40 Further, Article 3(3) of the Regulation establishing BEREC[93] requires NRAs to take utmost account of any opinion, recommendation, guidelines, advice or regulatory best practice adopted by BEREC.

A6.41 Accordingly, we have taken due account of the applicable EC recommendations and utmost account of the applicable opinions, recommendations, guidelines, advice and regulatory best practices adopted by BEREC relevant to the matters under consideration in this review.

Impact assessment – section 7 of the Act

A6.42 The analysis presented in the whole of this document represents an impact assessment, as defined in section 7 of the Act.

[93] Regulation (EC) No 1211/2009 of the European Parliament and of the Council of 25 November 2009 establishing the Body of European Regulators of Electronic Communications (BEREC) and the Office (the BEREC Regulation) http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:337:0001:0010:EN:PDF.

A6.43 Impact assessments provide a valuable way of assessing different options for regulation and showing why the preferred option was chosen. They form part of best practice policy-making. This is reflected in section 7 of the Act, which means that generally Ofcom has to carry out impact assessments where there is likely to be a significant effect on businesses or the general public, or when there is a major change in Ofcom's activities. However, as a matter of policy, Ofcom is committed to carrying out and publishing impact assessments in relation to the great majority of its policy decisions.[94]

A6.44 Specifically, pursuant to section 7, an impact assessment must set out how, in our opinion, the performance of our general duties (within the meaning of section 3 of the Act) is secured or furthered by or in relation to the regulation we impose.

A6.45 Ofcom is separately required by statute to assess the potential impact of all our functions, policies, projects and practices on race, disability and gender equality. This assessment is set out in Annex 12.

Regulated entity

A6.46 The power in the Act to impose an SMP obligation by means of an SMP services condition provides that it is to be applied only to a 'person' whom we have determined to be a person having SMP in a specific market for electronic communications networks, electronic communications services or associated facilities (i.e. the 'services market').

A6.47 The Framework Directive requires that, where an NRA determines that a relevant market is not effectively competitive, it shall identify 'undertakings' with SMP in that market and impose appropriate specific regulatory obligations. For the purposes of EU competition law, 'undertaking' includes companies within the same corporate group (for example, where a company within that group is not independent in its decision making).

A6.48 We consider it appropriate to prevent a dominant provider to whom an SMP services condition is applied, which is part of a group of companies, exploiting the principle of corporate separation. The dominant provider should not use another member of its group to carry out activities or to fail to comply with a condition, which would otherwise render the dominant provider in breach of its obligations.

A6.49 To secure that aim, we apply the SMP conditions to the person in relation to which we have made the market power determination in question by reference to the so-called 'Dominant Provider', which we define as *"[X plc], whose registered company number is [000] and any [X plc] subsidiary or holding company, or any subsidiary of that holding company, all as defined in section 1159 of the Companies Act 2006"*.

[94] For further information about Ofcom's approach to impact assessments, see the guidelines, *Better policy-making: Ofcom's approach to impact assessment*, which are on the Ofcom website: http://stakeholders.ofcom.org.uk/binaries/consultations/better-policy-making/Better_Policy_Making.pdf.

A7. General analytical approach to market definition, SMP assessment and remedies

A7.1 This annex sets out in general terms the processes that we have followed in defining the markets within this review, how and on what basis we assess whether any operator has SMP in a given market, whether SMP conditions should be imposed in a relevant market, and in what form. Sections 4, 5, 6 and 12 (market definition, the three-criteria test and SMP analysis respectively) set out in more detail how we have applied our analytical approach in each of the markets we are considering.

Overview of approach

A7.2 The market review procedure requires us to analyse markets in order to determine whether they are effectively competitive, and then to decide on appropriate remedies if necessary. Before an assessment of competitive conditions is possible it is necessary to define the relevant market.

A7.3 The definition of the relevant market does not simply entail identifying services that resemble each other in some way, but the set of services (and geographical areas) that exercise some competitive constraint on each other. It therefore has two dimensions:

- the relevant products or services to be included within the market; and
- the geographic extent of the market.

A7.4 It is often practical to define the relevant product market before exploring the geographic dimension of the market.

A7.5 The market definition exercise is not an end in itself, but a means to assessing whether there is effective competition and thus whether there is a need for *ex ante* regulation. It is in this light that we have conducted our market definitions in this review.

2014 EC Recommendation and the three-criteria test

A7.6 As explained in Annex 6, in defining markets for market review purposes, we are required to define relevant markets appropriate to national circumstances in accordance with the principles of competition law. In doing so we have taken due account of the 2014 EC Recommendation, the accompanying Explanatory Note and the EC SMP Guidelines.

A7.7 As explained in Annex 6, the 2014 EC Recommendation identifies a set of product and service markets within the electronic communications sector in which *ex ante* regulation may be warranted. NRAs may also identify markets that differ from those in the 2014 EC Recommendation which may be susceptible to *ex ante* regulation having regard to the three-criteria test.

A7.8 The three-criteria test is related to the assessment of SMP and involves the assessment of similar evidence, but is analytically distinct. The three-criteria test focuses on overall market characteristics and structure, for the sole purpose of identifying those markets that

are susceptible to *ex ante* regulation. In contrast, assessment of SMP involves determining whether an operator active in a market that has been identified as being susceptible to *ex ante* regulation should be made subject to *ex ante* regulation.[95]

The time period under review

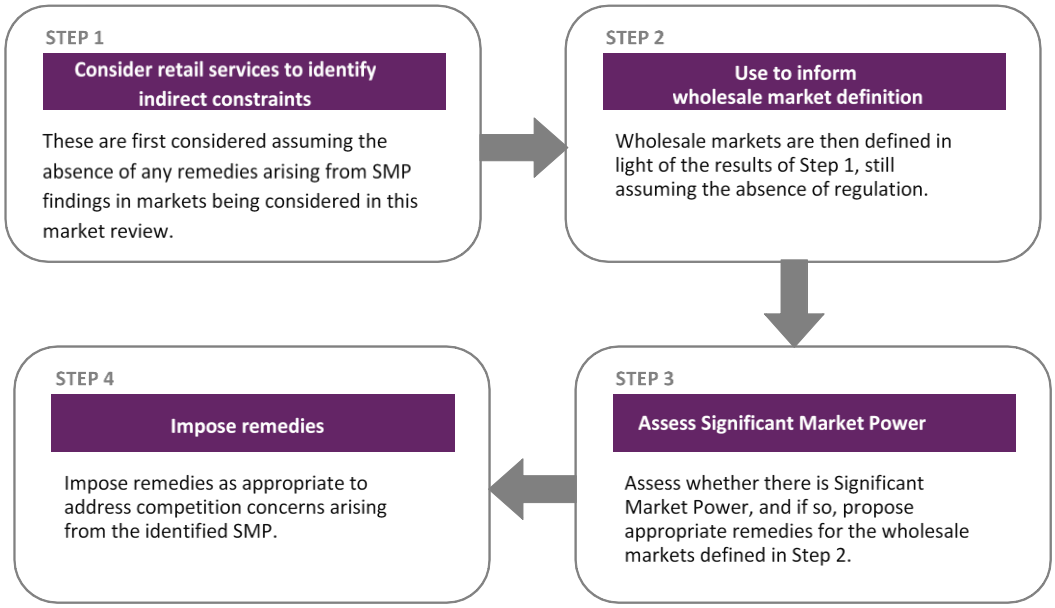
A7.9 Rather than just looking at the current position, market reviews look ahead to how competitive conditions may change in future. Our evaluation of the current market takes into account past developments and evidence, before then considering the foreseeable market changes that we expect to affect its development over the period to March 2021. This forward looking period reflects the period covered by this market review.

A7.10 The forward look period that we have used does not preclude us reviewing the market before that point should the market develop in a way we have not foreseen, to the extent that it is likely to affect the competitive conditions that are operating.

Market review process

A7.11 The market review process can be characterised as having four stages, which are shown in Figure A7.1 below.

Figure A7.1 Sequencing of market definition, SMP and remedies analysis



Source: Ofcom

A7.12 These steps are explained further in the following sub-sections.

[95] See the Commission Explanatory Note accompanying the 2014 EC Recommendation.

Market definition

A7.13 The starting point for identifying markets which may be susceptible to *ex ante* regulation is the consideration of retail markets from a forward-looking perspective. The wholesale market is defined subsequent to this exercise being carried out. In relevant cases we then consider whether the wholesale market is one in which *ex ante* regulation may be appropriate (if so, we have then formally identified a relevant market).[96]

A7.14 Consideration of retail markets is logically prior to wholesale market definition because the demand for the upstream wholesale service is a derived demand, meaning that the level of the demand for the upstream input depends on the demand for the retail service.

A7.15 This link between the retail and wholesale level means that the range of available substitutes at the downstream (retail) level will inform the likely range of competitive constraints acting at the upstream (wholesale) level. This is because a rise in the price of a wholesale service which is passed through to the price of retail services may cause retail customers to switch to substitute retail products, reducing demand for the wholesale input. We refer to this as an indirect constraint.

A7.16 Consequently, the analysis of the retail and wholesale levels of the supply-chain should be regarded as one exercise, the ultimate purpose of which is to define those wholesale markets in the UK where there may be a requirement for the imposition of *ex ante* regulation.[97]

Demand-side and supply-side substitution

A7.17 The boundaries between markets are determined by identifying competitive constraints on the price setting behaviour of firms. There are two main constraints to consider[98]:

- to what extent it is possible for a customer to substitute other services for those in question in response to a relative price increase (demand-side substitution); and
- to what extent suppliers can switch, or increase, production to supply the relevant products or services in response to a relative price increase (supply-side substitution).

A7.18 The hypothetical monopolist test (HMT) is a tool which can be used to identify close demand-side and supply-side substitutes.[99] In this test, a product is considered to constitute a separate market if the hypothetical monopolist supplier could impose a small but significant non-transitory increase in price (SSNIP) above the competitive level without losing sales to such a degree as to make this price rise unprofitable. If such a price rise would be unprofitable, because consumers would switch to other products or because

[96] See recital 5 and point 2 of the 2014 EC Recommendation.
[97] See, in this respect, recital 7 of the 2014 EC Recommendation which states that "the starting point for the identification of wholesale markets susceptible to *ex ante* regulation is the analysis of corresponding retail markets". See also section 2.1 of the Explanatory Note to the 2014 EC Recommendation and paragraph 44 of the SMP Guidelines.
[98] See paragraph 38 of the SMP Guidelines, which also notes that potential competition also acts as a third source of competitive constraint on an operator's behaviour, but is taken into account in the SMP assessment.
[99] See paragraph 41 of the SMP Guidelines.

suppliers of other products would begin to compete with the hypothetical monopolist, then the market definition should be expanded to include the substitute products.

A7.19 We must first therefore address the issue of which product(s) should form the starting point for the application of the HMT. This starting point can be referred to as the 'focal product'[100], and typically starts from the narrowest potential market definition.[101]

A7.20 Having considered demand-side substitution we then, where relevant, assess supply-side substitution possibilities to consider whether they provide any additional constraints on the pricing behaviour of the hypothetical monopolist which have not been captured by the demand-side analysis. In this assessment, supply-side substitution is considered to be a low-cost form of entry which can take place within a reasonable timeframe (e.g. up to 12 months).

A7.21 For supply-side substitution to be relevant not only must suppliers be able, in theory, to enter the market quickly and at low cost by virtue of their existing position in the supply of other products or geographic areas, but there must also be an additional competitive constraint arising from such entry into the supply of the service in question.

A7.22 Therefore, in identifying potential supply-side substitutes, it is important that providers of these services have not already been taken into consideration. There might be suppliers who provide other services but who might also be materially present in the provision of demand-side substitutes to the service for which the hypothetical monopolist has raised its price. Such suppliers are not relevant to supply-side substitution since they supply services already identified as demand-side substitutes. However, the impact of expansion by such suppliers can be taken into account in the assessment of market power.

Relevance of existing regulation- the modified Greenfield approach

A7.23 When we conduct our analysis we use the modified Greenfield approach.[102] This requires us to assess whether markets are effectively competitive from a forward-looking perspective in the absence of any regulation that would result from a finding of SMP. To do otherwise would be circular.

A7.24 However, it remains appropriate to take into account *ex ante* regulation arising from SMP findings in markets either upstream from, or horizontally related to, the services of interest.

Bundling

A7.25 A common feature of the telecoms sector is the supply of bundles of different services. However, the Explanatory Note explains that the fact that bundling is a trend observed at

[100] This reflects the terminology used by the OFT (OFT, Market definition, December 2004, OFT403, www.oft.gov.uk/shared_oft/business_leaflets/ca98_guidelines/oft403.pdf).
[101] Paragraph 3.2 of the OFT Market Definition Guidelines explains that 'previous experience and common sense will normally indicate the narrowest potential market definition, which will be taken as the starting point for the analysis'.
[102] See also Section 2.5 of the Explanatory Note to the 2014 EC Recommendation.

the retail level does not require the definition of retail market(s) for bundles. This is because evidence to date has not indicated that there is a need for *ex ante* regulation of bundles, which may contain a previously regulated input.[103]

A7.26 The Explanatory Note goes on to explain that what matters in this regard is that:

> "NRAs are able to ensure that the vertically integrated SMP operator's regulated elements of the bundle can be effectively replicated (in terms of both technical and economic replicability) at the retail level, without an implicit extension of regulation to other components which are available under competitive conditions".

Aggregating markets

A7.27 In certain circumstances, it may also be appropriate to define a product or geographic market by grouping together services despite the absence of demand- and supply-side substitutability.

Homogeneity of competitive conditions

A7.28 Aggregating markets on the basis of the homogeneity of competitive conditions can help streamline the subsequent market power analysis by reducing the need to review multiple markets for products, the provision of which is subject to homogeneous competitive conditions.

A7.29 However, combining products and services based on homogenous competitive conditions, is – by definition – only appropriate where this would not substantively alter any subsequent findings of SMP (relative to defining those markets separately).

A7.30 Our approach also takes into account the SMP Guidelines. In particular, in the context of geographic market analysis, paragraph 56 of the SMP Guidelines states that:

> "According to established case-law, the relevant geographic market comprises an area in which the undertakings concerned are involved in the supply and demand of the relevant products or services, in which area the conditions of competition are similar or sufficiently homogeneous and which can be distinguished from neighbouring areas in which the prevailing conditions of competition are appreciably different.[…]"

A7.31 Hence, subject to the relevant caveats above, where there are products (or geographic areas) where competitive conditions are sufficiently homogeneous, the definition of the relevant market will include all of those products (or geographic areas) within one market.

Common pricing constraints

A7.32 Another factor that is sometimes considered in setting market boundaries is whether there exist common pricing constraints across customers, services or geographic areas (for example, areas in which a firm voluntarily offers its services at a uniform price). Where

[103] See Section 3.2 of the Explanatory Note to the 2014 EC Recommendation.

common pricing constraints exist, the products or geographic areas in which they apply could be included within the same relevant market even if demand-side and supply-side substitution is limited (or absent). Failure to consider the existence of a common pricing constraint could lead to unduly narrow markets being defined.

Geographic market

A7.33 In addition to the product(s) to be included within a market, market definition requires us to specify the geographic extent of the market in which conditions of competition are sufficiently similar.

A7.34 One approach would be to begin with a narrowly defined geographic area and then consider whether a price increase by a hypothetical monopolist in that area would encourage customers to switch to suppliers located outside the area (demand-side substitution) or telecoms providers outside the area to begin to offer services in the area (supply-side substitution). If demand- and/or supply-side substitution is sufficient to constrain prices, then it is appropriate to expand the geographic market boundary.

A7.35 We recognise that in certain communications (product) markets, there may be different competitive conditions in different geographic areas. In this case, we therefore have to consider whether it is appropriate to identify separate geographic markets for some services. Defining separate markets by geographic area may be problematic because, due to the dynamic nature of communications markets, the boundary between areas where there are different competitive pressures may be unstable and change over time .

A7.36 An alternative approach is to define geographic markets in a broader sense. This involves defining a single geographic market but recognising that this single market has local geographic characteristics. That is to say, recognising that within the single market there are geographic areas where competition is more developed than in other geographic areas. This avoids the difficulties of defining and remedying large numbers of markets and instability in the definition over time. Such an approach may also include the aggregation of markets as discussed above.

Market power assessment

A7.37 Having identified the relevant product and geographic market(s) and, where relevant having identified the market as susceptible to *ex ante* regulation, we go on to analyse each market in order to assess whether any person or persons have SMP as defined in section 78 of the Act (construed in accordance with Article 14 of the Framework Directive). Section 78 of the Act provides that SMP is defined as being equivalent to the competition law concept of dominance in accordance with Article 14(2) of the Framework Directive which provides:

> "An undertaking shall be deemed to have significant market power if, either individually or jointly with others, it enjoys a position equivalent to dominance, that is to say a position of economic strength affording it the power to behave to an

> appreciable extent independently of competitors, customers and ultimately consumers."

A7.38 Further, Article 14(3) of the Framework Directive states that:

> "Where an undertaking has significant market power on a specific market, it may also be deemed to have significant market power on a closely related market, where the links between the two markets are such as to allow the market power held in one market to be leveraged into the other market, thereby strengthening the market power of the undertaking."

A7.39 Therefore, in the relevant market, one or more undertakings may be designated as having SMP where that undertaking or undertakings enjoy a position of dominance. Also, an undertaking may be designated as having SMP where it could lever its market power from a closely related market into the relevant market, thereby strengthening its market power.

A7.40 In assessing whether an undertaking has SMP, we take due account of the SMP Guidelines as we are required to do under section 79 of the Act.

The criteria for assessing SMP

A7.41 The SMP Guidelines require NRAs to assess whether competition in a market is effective. This assessment is undertaken through a forward-looking evaluation of the market (i.e. determining whether the market is prospectively competitive), taking into account foreseeable developments and a number of relevant criteria.[104]

A7.42 Our assessments of SMP are concerned with the prospects for competition over the review period of three years. Ultimately, we want to understand how the markets are likely to develop, and whether competition is likely to be, or become, effective during this review period. Below we set out certain key factors that we are likely to consider when assessing SMP.[105]

A7.43 Where a market is found to be competitive then no SMP conditions can be imposed. Section 84(4) of the Act requires that any SMP condition in that market, applying to a person by reference to a market power determination made on the basis of an earlier analysis, must be revoked.

Market shares

A7.44 In the SMP Guidelines, the EC discusses market shares as being an indicator of (although not sufficient to establish) market power:

> "…Market shares are often used as a proxy for market power. Although a high market share alone is not sufficient to establish the possession of significant market power (dominance), it is unlikely that a firm without a significant share of the relevant market would be in a dominant position. Thus, undertakings with market

[104] See, for example, paragraphs 19 and 20, and the opening words of paragraph 75, of the SMP Guidelines.
[105] The factors listed in this annex are not intended to be exhaustive and other evidence may be relevant.

> shares of no more than 25% are not likely to enjoy a (single) dominant position on the market concerned. In the Commission's decision making practice, single dominance concerns normally arise in the case of undertakings with market shares of over 40%, although the Commission may in some cases have concerns about dominance even with lower market shares, as dominance may occur without the existence of a large market share. According to established case-law, very large market shares — in excess of 50% — are in themselves, save in exceptional circumstances, evidence of the existence of a dominant position…"[106]

A7.45 Market shares and market share trends provide an indication of how competitive a market has been in the past. If a firm has a persistently high market share, then that in itself gives rise to a presumption of SMP. However, changes in market share are also relevant to our assessment of prospects for competition. For example, a market share trend which shows a decline may suggest that competition will provide an effective constraint within the time period over which the SMP assessment is being conducted, although it does not preclude the finding of SMP.[107]

Other factors affecting competitive constraints

A7.46 In addition to market shares, the SMP Guidelines set out a number of criteria that can be used by NRAs to measure the power of an undertaking to behave to an appreciable extent independently of its competitors, customers and consumers, including[108]:

- the overall size of the undertaking;
- control of infrastructure not easily duplicated;
- technological advantages or superiority;
- easy or privileged access to capital markets/financial resources;
- product/services diversification (e.g. bundled products or services);
- economies of scale;
- economies of scope;
- vertical integration;
- highly developed distribution and sales network;
- absence of potential competition; and
- barriers to expansion.

A7.47 A dominant position can derive from a combination of these criteria, which when taken separately may not necessarily be determinative.

A7.48 An SMP analysis may also take into account the extent to which products or services within the market are differentiated. The constraint from products or services outside the relevant market may also be a relevant factor.

[106] SMP Guidelines, paragraph 75.
[107] Paragraph 75 of the SMP Guidelines.
[108] SMP Guidelines, paragraph 78.

Excess pricing and profitability

A7.49 In a competitive market, individual firms should not be able to persistently raise prices above costs and sustain excess profits.

A7.50 The ability, therefore, to price at a level that keeps profits persistently and significantly above the competitive level is an important indicator of market power. The SMP Guidelines refer to the importance, when assessing market power on an *ex ante* basis, of considering the power of undertakings to raise prices without incurring a significant loss of sales or revenue.[109] Factors that may explain excess profits in the short term, such as greater innovation and efficiency, or unexpected changes in demand, should however be considered in interpreting high profit figures.

A7.51 However, consistently low profits, i.e. profits at or below the cost of capital, cannot be taken as evidence of an absence of market power. It may simply be evidence of inefficiency or other factors such as predatory pricing. For example, if a firm with SMP were to have inefficiently high costs, it may charge a price above the level we would expect to see in a competitive market but this would not result in high profits. In addition, price regulation exists in many of the wholesale markets considered, and therefore low profits may simply be the result of existing regulation rather than a reflection of the underlying competitive conditions.

Barriers to entry and expansion

A7.52 Entry barriers are important in the assessment of potential competition.[110] The lower entry barriers are, the more likely it is that potential competition will prevent undertakings already within a market from profitably sustaining prices above competitive levels. Moreover, the competitive constraint imposed by potential entrants is not simply about introducing a new product to the market. To be an effective competitive constraint, a new entrant must be able to attain a large enough scale to have a competitive impact on undertakings already in the market. This may entail entry on a small scale, followed by growth. Accordingly, whether there are barriers to expansion is also relevant to an SMP assessment. Many of the factors that may make entry harder might also make it harder for undertakings that have recently entered the market to expand their market shares and hence their competitive impact.

A7.53 A related factor is the growth in demand in the market. In general, telecoms providers are more willing to invest in a growing market (and less willing in a declining market). As a result, barriers to entry and expansion tend to be less of an impediment to competition in rapidly growing markets.

[109] SMP Guidelines, paragraph 73
[110] SMP Guidelines, paragraph 80

Countervailing buyer power

A7.54 A concentrated market need not lead to harmful outcomes if buyers have sufficient countervailing buyer power to curtail the exercise of market power. In general, purchasers may have a degree of buyer power where they purchase large volumes and can make a credible threat to switch supplier or to meet their requirements through self-supply to a significant degree. It is important to note, however, that the volumes involved must be large enough to make a material difference to the profitability of the current supplier. That is, an individual wholesale customer must represent a significant proportion of the total volume supplied by the relevant telecoms provider.

A8. Equality impact assessment

A8.1 Ofcom is required by statute to assess the potential impact of all our functions, policies, projects and practices on equality.[111] An equality impact assessment (EIA) also assists us in making sure that we are meeting our principal duty of furthering the interests of citizens and consumers regardless of their background or identity.

A8.2 Unless we state otherwise in this document, it is not apparent to us that our remedies will have a differential impact on any equality group.

A8.3 We have considered whether the remedies would have an adverse impact on promoting equality. In particular, we have considered whether the remedies would have a different or adverse effect on UK consumers and citizens with respect to the following equality groups: age, disability, sex, gender reassignment, pregnancy and maternity, race, religion or belief and sexual orientation, and, in Northern Ireland, political opinion and persons with dependents.

A8.4 The intention behind our approach to regulating the narrowband markets is to impose a set of regulatory obligations on telecoms providers with SMP that will promote competition by, for example, requiring them to provide access to their networks on regulated terms, and to protect consumers by preventing abusive conduct such as excessive pricing or a price squeeze.

A8.5 To understand how our decisions may affect equality groups, we have considered how different groups in society engage with communications services. In particular, we conducted market research that enabled us to assess the potential impact of future regulation on certain equality groups, particularly older consumers.[112] While our research identifies differences in take-up and use of fixed line services by different groups within society our decisions are aimed at promoting competition across the range of fixed voice telephony services.

A8.6 We consider that our decisions will not have a detrimental impact on any defined equality group. Further, we have not carried out separate EIAs in relation to race, gender equality or equality schemes under the Northern Ireland and Disability Equality Schemes. This is because we consider that our decisions will not have a differential impact on people of different genders or ethnicities, consumers with protected characteristics in Northern Ireland or on disabled consumers compared to consumers in general.

A8.7 Rather, we consider that our decisions will further the aim of advancing equality of opportunity between different groups in society by furthering the interest of all consumers in the retail fixed voice markets.

[111] We explain why we undertake an EIA and how we have done it in Section 2 of this statement. Ofcom has a general duty under the 2010 Equality Act to advance equality of opportunity in relation to age, disability, sex, gender reassignment, pregnancy and maternity, race, religion or belief and sexual orientation.
[112] 2017 Saville Rossiter-Base market research.