Deloitte.

Volume Forecasts in Ofcom's Proposed NGN model.

A Report for BT

9 November 2012

This report has been prepared on the basis of the limitations set out in the engagement letter and the matters noted in the Important Notice From Deloitte on page 1.

Contents

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Executive Summary

Ofcom has recently conducted a consultation in relation to "Fixed Narrowband Market Review and Network Charge Control". Following this initial call for inputs, Ofcom initiated further discussions with BT and other stakeholders on the implementation of the proposed regulatory remedies imposed on significant market power (SMP) operators and published a second consultation document "Consultation on possible approaches to cost modelling for the Network Charge Control for the period 2013-2016".

Ofcom has also published a draft Next Generation Network (NGN) cost model ("proposed NGN model") and documentation ("proposed NGN model documentation"). The proposed NGN model is a bottom-up long run incremental cost (LRIC) model, containing assumptions on key parameters. As part of its consultation process, Ofcom is seeking respondent's view on the appropriateness of the proposed NGN model and the input assumptions adopted.

Key findings

A number of issues have been identified in the approach that has been employed by Ofcom to forecast volumes. Addressing these areas in the manner suggested below have the potential to improve the forecasts.

- Ofcom has forecast the total number of lines by forecasting the number of lines / channels per household and then multiplied by a forecast of the number of households. This has led to a U shaped profile for the total number of lines / channels. An alternative approach would be to calculate the volumes directly, resulting in a downward trend.

- In some cases the forecasts do not reflect data from Communications Market Report or volumes are entered incorrectly into the model. The model should be updated with the relevant information:

    - Volume data for 2011/12 (available from the 2012 Communications Market Report) should be added to the service volume inputs of the proposed NGN model. The number of broadband lines appearing in the model could be reconciled with the figures in the 2012 Communications Market Report.

- The number of non geographic minutes should be reconciled with the 2012 Communications Market Report and the model should be recoded so that non geographic minutes are considered in the network dimensioning.

- For each volume to be forecast, Ofcom adopts a dampening factor to smooth the magnitude of the historic trend. The choice of this dampening factor requires careful consideration, as opposed to Ofcom's assumption of a dampening factor of 1.5 for all voice volumes and of 1.3 for all data volumes. For each volume to be forecast, the dampening factor which delivers the best extrapolation of historic volume trends could be selected. In particular, the dampening factor should be adjusted to reflect the decreasing trend in fixed

lines and the expectation that new households will have a lower adoption of fixed lines compared to the stock of households.

- Ofcom calculates incoming minutes indirectly by converting the number of originating minutes. This leads to an increase in incoming minutes in later years which does not accord with historic trends or analyst predictions. Instead, Ofcom should calculate both originating and terminating volumes directly, ensuring that a continuous downward sloping trend is achieved.

- Ofcom's forecasts imply that a maximum broadband penetration of households of 84.5% is reached. Maximum broadband penetration should be recalculated to reflect historic growth rates and analyst prediction, to be no higher than 82% with a less steep increase in broadband bandwidth.

- Ofcom produces a single forecast for broadband lines and does not recognise differences in how the network is dimensioned for the two types. Instead, separate forecasts should be produced for copper and fibre based broadband lines, recognising the higher relative growth rates that are expected for fibre based broadband. Furthermore, the network should be redimensioned to recognise that fibre based broadband traffic is lifted off at the cabinet and therefore a higher proportion of the network will be driven by voice traffic.

Ofcom's approach to forecasting volumes

Ofcom has adopted three approaches to estimating the volumes for the proposed NGN model covering different time periods:

- 2005/06 to 2010/11: volume forecasts are based on historical information from its market intelligence reports.

- 2011/12 to 2024/25: volume forecasts are calculated using a three year average growth formula with a dampening factor applied to smooth the volume growth overtime.

- 2025/26 to 2045/45: volumes are assumed to remain constant.

Review of Ofcom's approach

Ofcom adopts a mixed arbitrary methodology with limited discussion for the choice of approach in the proposed NGN model or accompanying documentation and makes a selective use of data in some areas.

1. The proposed NGN model documentation reports that "*forecasts [are] based on a 3 year average growth rate with dampening factor*". However, Ofcom only considers a geometric mean of the past growth rates and does not provide a discussion as to why this should be used as opposed to an arithmetic mean.

2. The rationale for basing forecasts on the average growth rate over the previous three years is not discussed in the proposed NGN model documentation. This may be contrasted with

the Ofcom 2010 Communications Market Reports where past trends are almost exclusively reported using a 5-year CAGR.

3. Ofcom does not use all available information in the model, for example data from its 2012 Communications Market Report. In some cases, the data is referenced but appears to have been incorrectly entered into the proposed NGN model, e.g. the number of broadband lines appearing as an input in Ofcom's proposed NGN model does not exactly match the figures in Ofcom's 2012 Communication Market Report.

4. The choice of the dampening factor appears to be arbitrarily set at 1.5 for voice, ISDN2 and ISDN30, and 1.3 for broadband without a strong rationale. Similarly, the choice of using the same dampening factor for fixed and mobile usage may be debated.

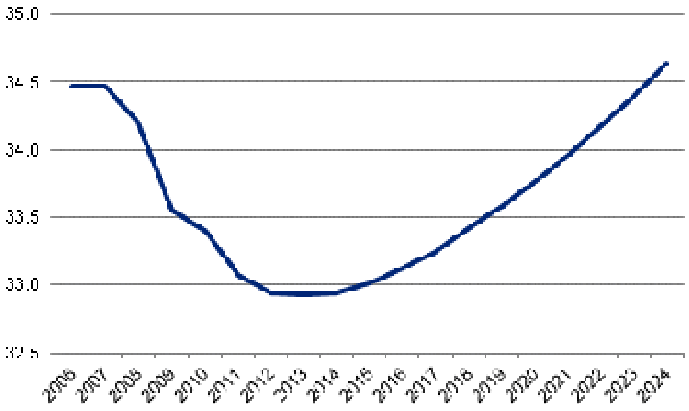
5. The same formula is used to forecast both residential and business traffic, and for local, national, international and mobile traffic. Also, the same formula is used for forecasting the number of voice, ISDN2, ISDN30 and broadband lines. For the latter, however, the dampening factor is 1.3 instead of 1.5.

Review of Ofcom's volume forecasts

A number of the volume forecasts appear overly optimistic when compared with historic trends and third party forecasts for a similar period.

Ofcom's forecast of the total number of lines/channels demonstrates a U-shaped trend. The historic trend in the number of total lines/channels is decreasing and no discussion is provided by Ofcom as to why this should change in the future.

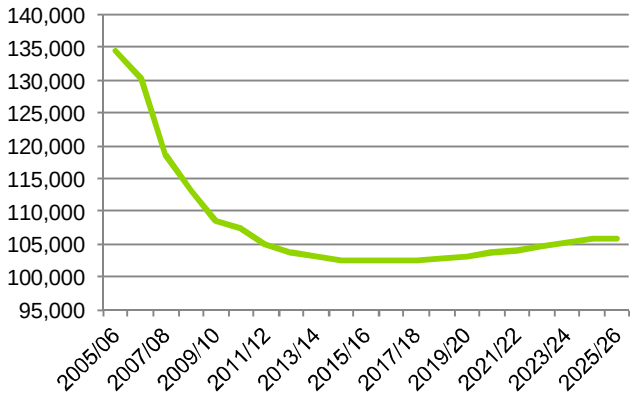
Figure 1: Total number of lines/channels (millions)



Source: Ofcom proposed NGN model

Ofcom's forecast of total originated minutes of use does not use the full set of available data or analysts' expectations on future usage. This results in a forecast of an increase in total minutes of use in the second half of the forecast period compared to the historical trend which has been declining over time.

Figure 2: Total minutes of use originated (millions)



Source: Deloitte analysis based on data in Ofcom proposed NGN model

A review of the proposed NGN model raises two concerns regarding the volume of call minutes originated from fixed to non geographic numbers:

- These minutes appear as an input in the proposed NGN model[1] but this input is not considered when calculating the total outgoing minutes.[2] The proposed NGN model calculates the total originating minutes from fixed lines as the sum of call minutes to local, national, international and mobile. Minutes from fixed to non geographic are not added to this calculation, despite being relevant to the estimation of the appropriate size of the proposed NGN the network.

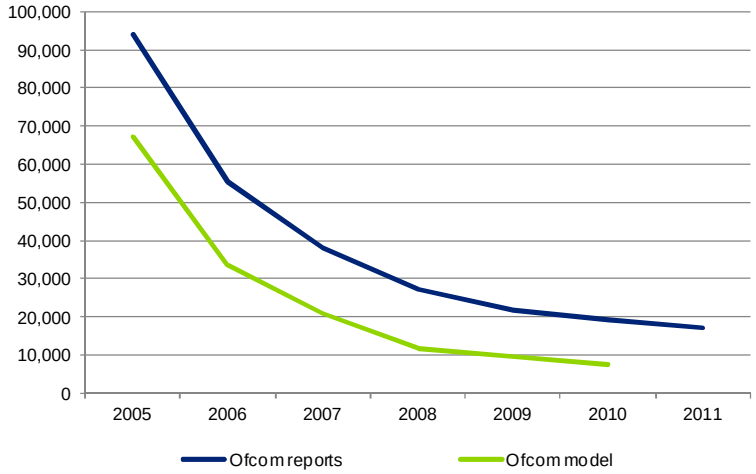
- The total number of minutes from fixed to non geographic appearing as an (unutilised) input in the Ofcom proposed NGN model does not match the information available in Ofcom's published market reports.[3]

[1] Ofcom proposed NGN model; file "Demand"; Tab "Traffic inputs".

[2] Ofcom proposed NGN model; file "Demand"; Tab "Voice and line".

[3] http://stakeholders.ofcom.org.uk/market-data-research/market-data/communications-market-reports/tables/

Figure 3: Total call minutes from fixed to non geographic numbers (millions)



Source: Deloitte analysis based on data from Ofcom proposed NGN model and Ofcom data from its market intelligence reports[4]

There are also concerns with regards to the manner in which Ofcom converts originating minutes to incoming minutes. Ofcom first forecasts total outgoing minutes.[5] Starting from these total outgoing minutes, Ofcom recovers the number of incoming minutes, and, in a subsequent step, allocates the total (outgoing and incoming) traffic to the following categories:

- Incoming voice calls.
- Outgoing off-net voice calls.
- On-net voice calls.
- Transit.

This method raises a number of concerns:

- Given the asymmetric nature of the outgoing and incoming traffic between fixed and mobile, this methodology does not seem to be the most appropriate to capture minutes from mobile to fixed. It would appear appropriate to also produce direct forecasts of "mobile to fixed" minutes.
- It adopts an indirect approach to forecasting traffic and makes it difficult to reconcile traffic forecasts back to Ofcom's market report. A more transparent approach would be to expand the number of call types in the demand module and to enter the traffic forecasts directly.

[4] http://stakeholders.ofcom.org.uk/market-data-research/market-data/communications-market-reports/tables/
For instance, see table 5 of the 2012 version of these documents. The number of minutes from fixed to non geographic numbers is not explicitly reported in these documents. However, Deloitte asked for clarifications and Ofcom explained that non geographic minutes represent 85%-90% of the category "Other calls".

[5] This is done in the file "Demand", tab "Voice and line" of the proposed NGN model.

Ofcom's forecast for the volume of broadband lines appears higher than might have been expected considering historical growth rates.

- There is no evidence to suggest that broadband penetration should be expected to exceed 82% in the future:
    - Ofcom data shows that household penetration of fixed lines has been decreasing since 2005/06. In 2012, 80% of UK households have both a fixed and a mobile connection (decreasing over time) and only 5% of UK households have a fixed connection only (decreasing over time). If these trends are extrapolated to the longer term, penetration of broadband should not be expected to exceed 82% in the future.
- Broadband bandwidth has been increasing over the last 5 years but at a decreasing rate. Ofcom instead assumes a steady 15% growth in broadband bandwidth until 2020/21.

Ofcom argues that its forecasts are supported by independent analyst reports, from Enders Analysis and Analysys Mason. However, a review of these reports suggests that this support is rather qualified.

- Enders Analysis does not provide specific long term volume forecasts, as the analysis mainly focuses on historic data.
- Forecasts by Analysys Mason suggest that Ofcom's projections might be too optimistic, especially regarding the number of fixed lines.

In addition, further third party forecasts are available and these are not discussed by Ofcom, and Gartner and Budde Communication provide useful quantitative and qualitative information on future market trends.

Finally, it should be noted that Ofcom's volume forecasting approach does not consider copper and fibre based broadband separately. Changing consumer preferences, the emergence of new bandwidth heavy devices, such as ultra high definition television and the greater availability of fibre broadband networks are likely to result in a relatively higher growth rate of fibre based broadband. This is important as traffic carried over fibre based broadband is lifted off the voice network at the cabinet and would not be carried on the network as modelled by Ofcom. As such, overall traffic levels are likely to be lower than those modelled by Ofcom and less of the network build driven by data traffic.

Alternative volume projections

An alternative set of projections have been constructed for the purpose of allow an informed debate over the volume forecasts within the proposed NGN model. These projections make use of three categories of new information:

- Use of 2011/12 data from Ofcom's Communications Market Report.
- The impact of evolving technologies and changing consumer preferences.

- Consistency with available third party forecasts.

A sensitivity analysis on some of Ofcom's key parameters has also been conducted.

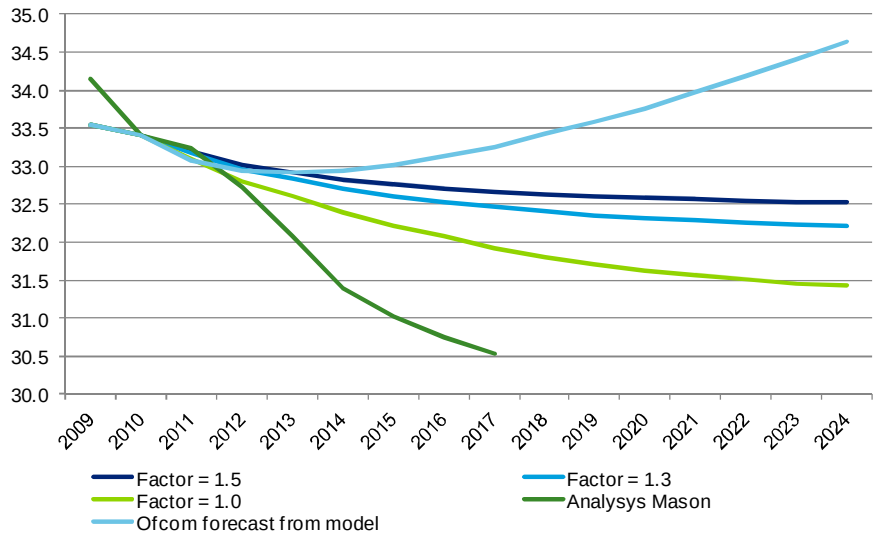
Two specific changes, in addition to taking account of third party forecasts, would appear likely to improve the quality of the forecasts of the total number of lines / channels:

- Forecasting total lines directly as opposed to lines per household or per business. This approach is more successful in capturing the decreasing historic trend in the total number of lines and removes the counterintuitive U-shaped trend in the number total lines (see Figure 1).

- Adjusting the dampening factor to reflect the decreasing trend in lines and the expectation that new households will have a lower adoption of fixed lines compared to the stock of households.

The following projections take account of these factors and lead to volume forecasts below those presented by Ofcom.

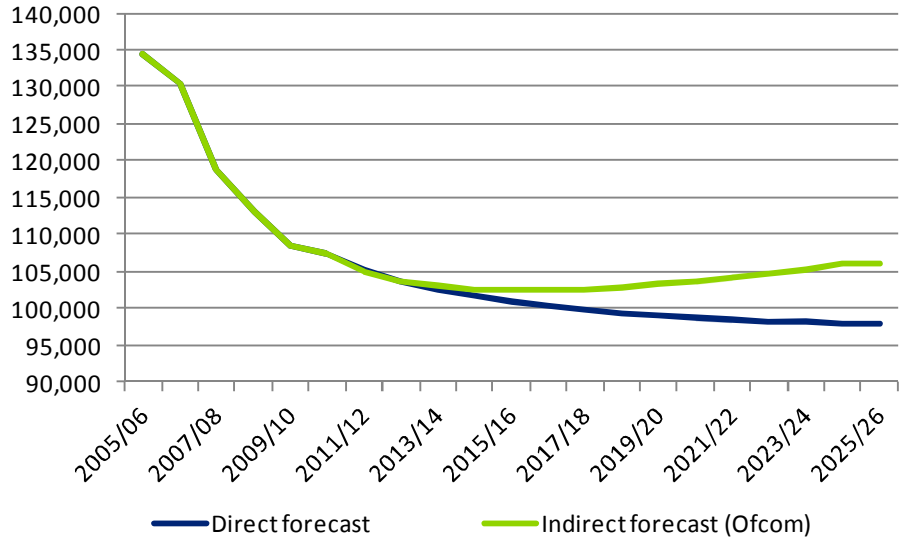
Figure 4: Total number of lines/channels (millions)



Source: Deloitte analysis based on data from Ofcom proposed NGN model and Analysys Mason; The Deloitte projections based on Ofcom data are presented for three different values of the dampening factor

In projecting the total originating minutes, an approach which considers the whole market directly again better reflects the historic declining trend.

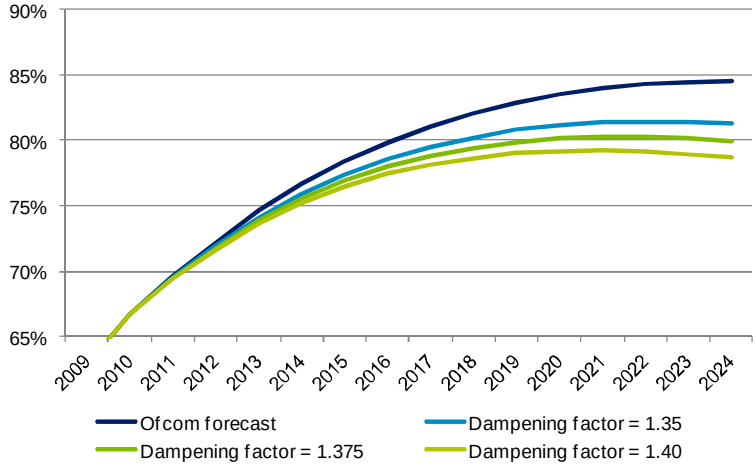
Figure 5: Projection of the total number of minutes, originating (millions)



Source: Deloitte analysis based on data from Ofcom proposed NGN model

In projecting the total number of broadband lines, adjusting the dampening factor would bring Ofcom's forecasts more in line with its own data on household broadband penetration and third parties' expectations on the growth in broadband lines.

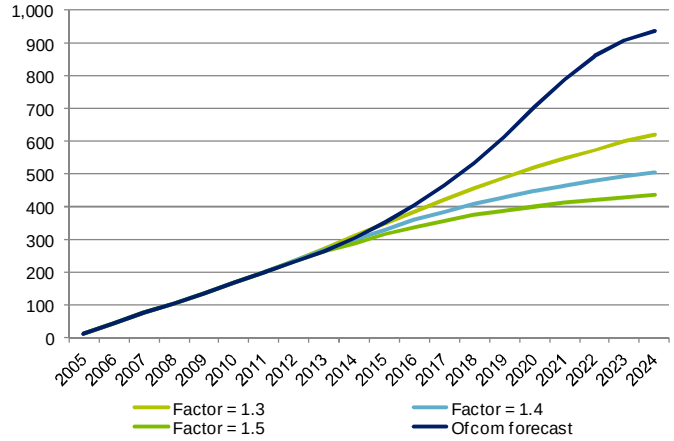
Figure 6: Projection of household penetration of broadband



Source: Deloitte analysis based on data from Ofcom proposed NGN model; The Deloitte projections based on Ofcom data are presented for three different values of the dampening factor

Similarly, Ofcom forecasts of broadband bandwidth appear overly optimistic compared to the historic trend in bandwidth growth. Revised projections adjusting the dampening factor partially narrow this gap.

Figure 7: Projection of broadband bandwidth per line (Kbit/s)



Source: Deloitte analysis based on data from Ofcom proposed NGN model; The Deloitte projections based on Ofcom data are presented for three different values of the dampening factor

There is evidence that Ofcom should separately calculate penetration and broadband bandwidth for copper and fibre based broadband, and should include explicit modelling of substitution between the two:

- Ofcom's data on the household availability of FTTC shows that fibre is rapidly becoming available to an increasing segment of customers. This trend is expected to further increase in the future as consumers further require fibre based broadband to meet their service needs.

- Ofcom's forecasts imply an expectation of steady growth of 15% year on year in broadband bandwidth until 2010/21. Whilst this may reflect the ongoing and expected increase in consumers' bandwidth requirements it may need to be tempered against the decreasing growth rate in broadband bandwidth over 2005-2010.

1 Introduction

1.1 Ofcom narrowband market review

On 17 May 2012, Ofcom issued a consultation calling for inputs into its "Fixed Narrowband Market Review and Network Charge Control" consultation. Ofcom's call for inputs invited opinions on the proposed scope of the review, the approach Ofcom should adopt in assessing competitive conditions in fixed narrowband markets, both retail and wholesale, and how these markets have changed since the last review in 2009. The deadline for responding to this consultation was 28 June 2012.

Following this initial call for inputs, Ofcom initiated further discussions with BT and other stakeholders on the implementation of the proposed regulatory remedies imposed on SMP operators and published a second consultation document "Consultation on possible approaches to cost modelling for the Network Charge Control (NCC) for the period 2013-2016", 28th September 2012.

Ofcom has also published a draft NGN cost model ('proposed NGN model') and documentation ('proposed NGN model documentation'). The proposed NGN cost model is a bottom-up LRIC model, containing assumptions on key parameters. As part of its consultation process, Ofcom is seeking respondent's view on the appropriateness of the model and the input assumptions.

1.2 Scope of this report

BT has commissioned Deloitte to review the volume forecasts that are being proposed by Ofcom within the proposed NGN model. The scope of this work comprises:

- A review of the volume forecasts proposed by Ofcom and the underlying methodology and assumptions used to generate these forecasts.
- Setting out volume forecasts that are available from third party sources.
- Considering the impact of evolving technologies and changing consumer preferences on volumes.
- Producing an alternative set of volume projections for the purpose of allowing an informed debate over the volume forecasts within the proposed NGN model forecasts that consider the above analysis.
- Producing a review of the network structure and assumptions in the proposed NGN model, focussing on the extent to which the dimensioned network is capable of providing the level of service required to meet the volume forecasts provided.[6]

This reports sets out the analysis that was undertaken into each of these areas.

[6] This review has been limited by the time available and it is likely that there are other areas of the model that require further consideration.

2 Ofcom's approach to the forecasting of volumes on fixed networks

This chapter sets out the approach that has been used by Ofcom to develop its volumes forecasts for use in the proposed NGN model and provides a review of this approach.

2.1 Overview of the approach

The proposed NGN model adopts a bottom-up engineering approach and assumes an efficient operator which uses an NGN-IP network. It is further assumed that voice calls are provided alongside certain types of data services on this network.[7] Traffic is transmitted as packets routed using the IP network with much of the network equipment being shared between voice and data services.[8] The capacity, and hence cost, of the network is a function of the level of traffic that it is required to carry.

Ofcom forecasts the traffic volumes by following a number of steps that are described in this section.

2.1.1 Step 1: Forecasts

Ofcom produces forecasts of volumes for the following services:

- Residential (business) voice lines and ISDN channels per household (business).[9]
- Residential (business) local/national/international/mobile call minutes originated per line/channel.[10]
- Total number of broadband lines; broadband bandwidth per line.

[7] Ofcom (2012): "Narrowband market review 2013-2016", p. 32.

[8] The model does not explicitly state to what extent voice lines and broadband lines overlap. Certainly, until when the migration to NGN is completed (2016) this sharing of equipment is not possible on the entire traffic. Ofcom uses two separate calculations to retrieve the number of voice lines and the number of broadband lines. Ofcom calculates the number of broadband lines as equal to the number of subscribers to broadband connections. These subscriptions are calculated as the sum of the subscriptions to "BT DSL", "other DSL", "cable" and "other" types of broadband connections. The number of voice lines instead is calculated as the number of households multiplied by the number of lines per households. The population forecasts are mainly taken from the office of national statistics and from the projections of the department for communities and local governments.

[9] Residential ISDN2 channels per household; Residential voice lines per household; Business ISDN2 channels per business; Business ISDN30 channels per business; Business voice lines per business.

[10] Residential (Business) local call minutes per line/channel; Residential (Business) national call minutes per line/channel; Residential (Business) international call minutes per line/channel; Residential (Business) mobile call minutes per line/channel.

2.1.2 Step 2: Aggregation

Ofcom aggregates the usage per line of the different types of traffic and obtains the average usage per line.[11] Taking into account the average usage per line and number of lines, Ofcom produces a forecast of the total traffic over the network.

2.1.3 Step 3: Allocation

A proportion of the total originated traffic is allocated to the modelled network according to the assumed market shares. The forecast total originated volumes are mapped across to the following traffic types:

- Incoming voice calls.
- Outgoing off-net voice calls.
- On-net voice calls.
- Transit.
- Packet data.

The consultation document reports that "*a description of how traffic voumes are used to dimension our modelled network can be found in Section 4 of Annex 7*".[12] However, the documentation available to Deloitte does not present any such Annex.

An analysis of how Ofcom recovers usage for each type of service raised a concern with respect to the way in which "mobile to fixed" minutes are recovered. The only input in the model is "fixed to mobile" minutes and, given the non-symmetric nature of these types of traffic, it would appear appropriate to also produce direct forecasts of "mobile to fixed" minutes.

2.2 Forecasting approach and key assumptions

2.2.1 Ofcom's approach to volume estimation

Ofcom has adopted three approaches to estimating the volumes for the proposed NGN model covering different time periods:

- 2005/06 to 2010/11: volumes are based on historical information from its market intelligence reports.
- 2011/12 to 2024/25: volumes forecasts are calculated using a three year average growth formula with a dampening factor applied to smooth the volume growth over time.
- 2025/26 to 2045/45: volumes are assumed to remain constant.

[11] Ofcom considers channels, rather than lines, as basic unit.

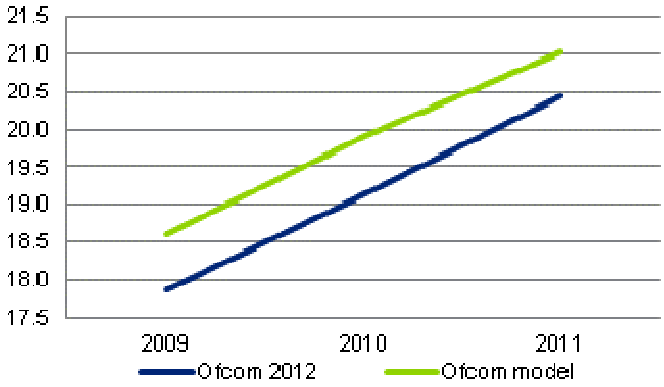
[12] Paragraph 5.23, page 35.

Volume estimations from 2005/06 to 2010/11

The source of the volume inputs for the period 2005 to 2011 is Ofcom's 2012 Communications Market Report.[13]

The number of minutes and fixed voice lines/channels are consistent between the model and the 2012 Ofcom's Communications Market Report. However, the number of broadband lines reported by the 2012 Communications Market Report differs substantially from the figures used in the model. In 2011 the volume forecast is approximately 0.57 million above the actual figure reported in the Market Report.

Figure 8: Number of broadband lines (millions)



Source: Ofcom proposed NGN model and Ofcom 2012 Communications Market Report

Ofcom's model currently bases its forecasts on historic data up to 2010/11. However, actual data for 2011/12 is readily available from the 2012 Communications Market Report. The consequences of not utilising the available 2011/12 data are be discussed in more detail in section 4.1.

Volume forecasts from 2011/12 to 2024/25

For the years from 2011/2012 to 2024/2025, Ofcom produces forecasts for the volume of voice and data traffic and the number of lines. This is based on the compounded annual growth rate (CAGR) over a three-year period and a dampening factor which smoothes this trend over time:

$$x_{t+1} = x_t\left(1 + \left(\left(\frac{x_t}{x_{t-3}}\right)^{\frac{1}{3}} - 1\right)\frac{1}{\tau}\right) \qquad \text{(Equation 1)}$$

For instance:

$$x_{2013} = x_{2012}\left(1 + \left(\left(\frac{x_{2012}}{x_{2009}}\right)^{\frac{1}{3}} - 1\right)\frac{1}{\tau}\right) \qquad \text{(Equation 2)}$$

[13] http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr12/CMR_UK_2012.pdf

The aim of this functional form is to predict next year's values (t+1) by replicating the trend of the previous 3 years (from t-3 to t), smoothed by a dampening factor (τ). This would forecast for next year (t+1) a value equal to that of the current year (t) increased or decreased depending on whether there has been growth or decline in the past three years.

Volume estimations from 2025/26 to 2045/46

For the period from 2025 to 2045 Ofcom assumes that both data and voice volumes will remain constant at the 2024/2025 levels.

2.2.2 Key assumptions

Dampening factors

Ofcom assumes that the observed volume trend will smooth out over the years. This is assumed to happen more quickly for voice services than for data services. The model further assumes a dampening factor of 1.5 for voice and 1.3 for data. For example, if the CAGR over the previous three years was 10%, the resulting growth rate used by Ofcom for its forecasts would be 10%/(dampening factor). Consequently, the growth rate would be reduced in magnitude. This dampening factor is the same for residential, business, national and international traffic. Also, the factor is constant for every year until 2025.

Transit v. non-transit traffic

The transit traffic is calculated as a proportion of the total traffic. Ofcom states that this proportion "is an estimate of the ratio of the transit traffic to non-transit traffic that a hypothetical network would carry".[14]

Data forecasts

Ofcom assumes that the split of total broadband lines between business and residential customers is 11% and 89% respectively. This ratio is kept constant over the modelled period. However, information from Ofcom suggests that it might be more appropriate to allow these percentages to vary over time:[15]

Table 1: Percentage of broadband lines that are residential

	2005/06	2006/07	20007/08	2008/09	2009/10
Ofcom model	89%	89%	89%	89%	89%
Ofcom historic data	87%	88%	90%	91%	92%

Source: Ofcom proposed NGN model and Deloitte analysis based on Ofcom proposed NGN model

[14] Ofcom (2012): "Narrowband market review 2013-2016", p. 32 note 93.

[15] Ofcom slides 2010. Figure 5.53.

Copper versus fibre broadband

There is an increasing take-up of fibre, as opposed to copper based broadband as customers demand the higher speeds it can deliver. Despite fibre based broadband having considerably different network requirements (as discussed in appendix A) separate forecasts are not provided in the model for copper and fibre based broadband.

Migration forecast from PSTN to NGN

The following tables show the percentage of lines that are assumed to be migrated from PSTN to NGN each year.

Table 2: Migration from PSTN to NGN

2005/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15
62%	62%	69%	69%	69%	88%	88%	95%	95%	100%

Source: Ofcom proposed NGN model; Based on calculations in "calc demand" in Network.xls

Ofcom assumes a high percentage of customers migrate in the first year which will lead to high levels of cost recovery in early years. This assumption may be questioned as Ofcom has not demonstrated that a NGN would be an MEA network in 2005/06 or that there was sufficient customer demand for NGN based services for BT to be able to economically realise this migration path.

2.3 Review of Ofcom's approach to forecasting

2.3.1 Methodology and assumptions

The methodology used by Ofcom adopts a relatively arbitrary approach with limited discussion for the choice of approach in the proposed NGN model or accompanying documentation, and makes a selective use of data in some areas.

- The proposed NGN model documentation reports that "forecasts [are] based on a 3 year average growth rate with dampening factor". However, Ofcom only considers a geometric mean of the past growth rates and does not provide a discussion as to why this should be used as opposed to an arithmetic mean.

- The rationale for basing forecasts on the average growth rate over the previous three years is not discussed in the proposed NGN model documentation. This may be contrasted with the Ofcom 2010 Communications Market Reports which almost exclusively expressed past trends in terms of a 5-year CAGR.

- Ofcom does not use all available information in the model, for example data from its 2012 Communications Market Report. In some cases, the data is referenced but appears to have been incorrectly entered into the proposed NGN model, e.g. the number of broadband lines appearing as an input in Ofcom's NCC model does not exactly match the figures in Ofcom's 2012 Communication Market Report.

- The choice of the dampening factor appears to be arbitrarily set at 1.5 for voice, ISDN2 and ISDN30, and 1.3 for broadband without a strong rationale. Similarly, the choice of using the same dampening factor for fixed and mobile usage may be debated.

- The same formula is used to forecast both residential and business traffic, and for local, national, international and mobile traffic. Also, the same formula is used for forecasting the number of voice, ISDN2, ISDN30 and broadband lines. For the latter, however, the dampening factor is 1.3 instead of 1.5.

Ofcom states in the consultation document "Consultation on possible approaches to cost modelling for the Network Charge Control for the period 2013-2016"[16] that its forecasts are supported by two independent analyst reports, by Enders Analysis and by Analysys Mason. However:

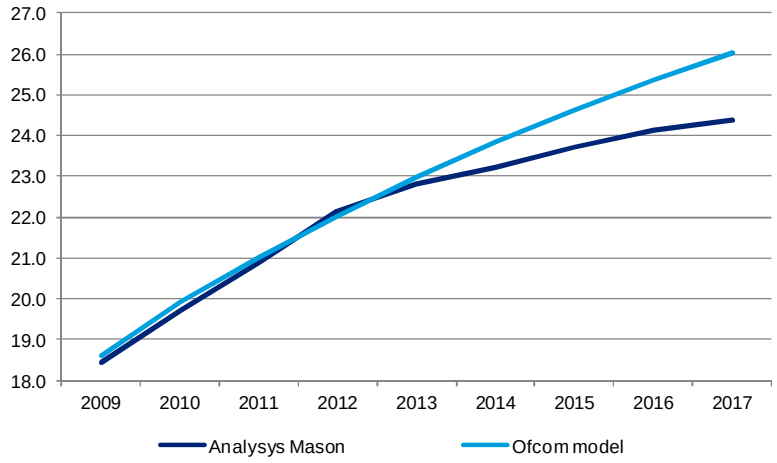
- The report by Enders Analysis[17] does not provide any specific long term volume forecasts. The analysis mainly focuses on historic data and only appears to express the view that in the third quarter of 2010 there would have been a strong growth in the broadband market.

Analysys Mason[18] produces forecasts for the number of lines/channels up to 2017. These forecasts only partially support Ofcom's forecasts:

- Whilst the number of broadband lines in the Analysys Mason's projections follows approximately the same trend, Ofcom's forecasts are more optimistic.

- The number of fixed lines in Analysys Mason's report follows a different trend to that forecast by Ofcom.

Figure 9: Number of broadband lines (millions)



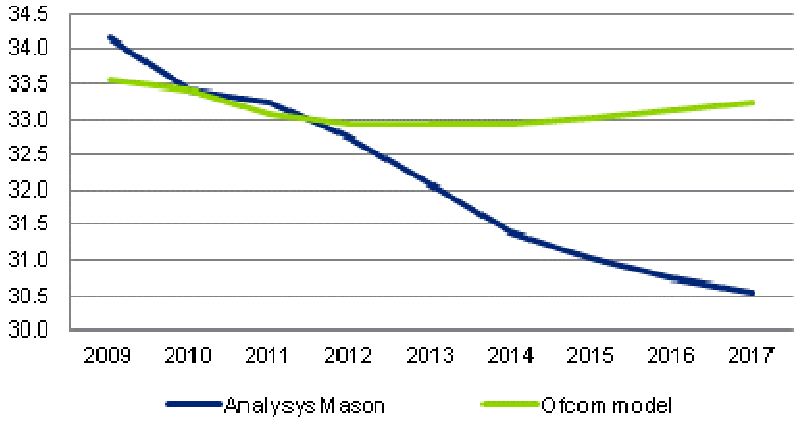
Source: Ofcom proposed NGN model; Analysys Mason

[16] Ofcom (2012): "Narrowband Market Review, Consultation on possible approaches to cost modelling for the Network Charge Control for the period 2013-2016", p.31, note 92.

[17] Enders Analysis: UK fixed line market analysis http://www.endersanalysis.com/content/publication/uk-broadband-and-telephony-trends-june-2010.

[18] Analysys Mason: Telecoms Market Trends and Forecasts 2011-2016. Deloitte employed the updated version (2012-2017) to conduct its analyses.

Figure 10: Total number of fixed lines/channels (millions)



Source: Ofcom proposed NGN model; Analysys Mason

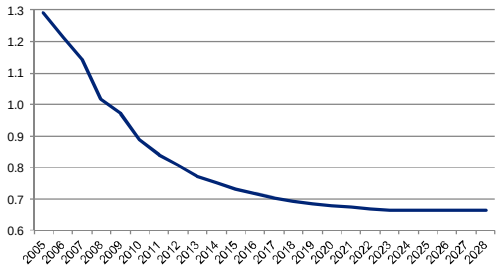
Further third party forecasts are available and can be used to provide a cross-check on Ofcom's forecasts. A number of these suggest that Ofcom's volume forecasts may be overly optimistic with regards to growth. A comparison of Ofcom's forecasts with third party forecasts is presented in section 4.2 of this report.

2.3.2 Ofcom's voice/ISDN forecasts

Number of lines/ channel

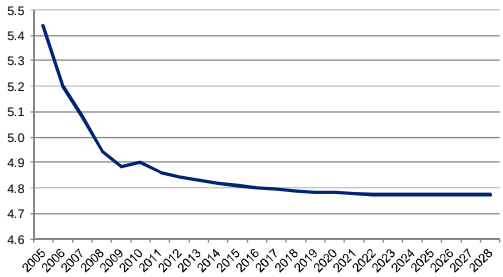
Rather than forecasting the total number of lines/channels, Ofcom forecasts the number of lines/channels per household or per business. The number of lines and channels per household or per business presents a decreasing trend as in the longer term new households and businesses are less likely to adopt a fixed line.

Figure 11: Business ISDN2 channels per business



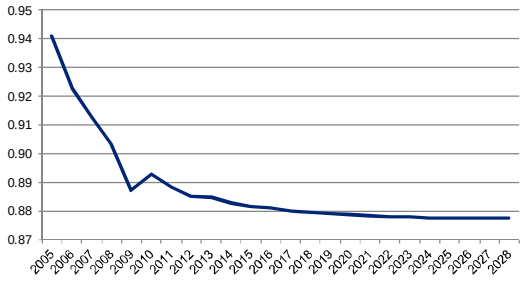
Source: Deloitte analysis based on data from Ofcom porposed NGN model

Figure 12: Business voice lines per business



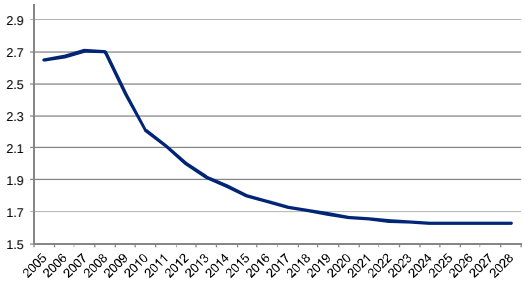
Source: Deloitte analysis based on data from Ofcom poposed NGN model

Figure 13: Residential voice lines per household



Source: Deloitte analysis based on data from Ofcom prposed NGN model

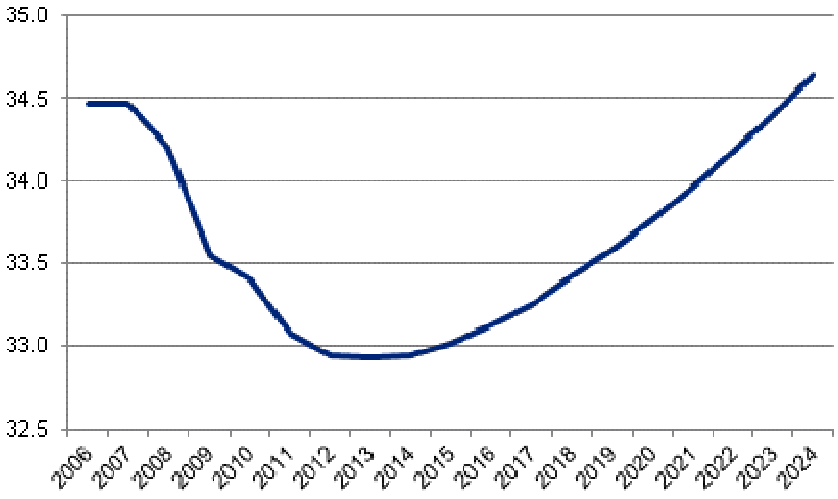
Figure 14: Business ISDN 30 channels per business



Source: Deloitte analysis based on data from Ofcom proposed NGN model

Having forecast the number of lines/channels per household (and business), Ofcom multiplies the number of lines/channels per household (and business) by the number of households (or businesses) in order to obtain the total number of lines/channels. This results in a counterintuitive U-shaped trend for the total number of lines which does not follow the historic trend and appears counter intuitive as shown below.

Figure 15: Total number of lines/channels (millions)



Source: Ofcom proposed NGN model

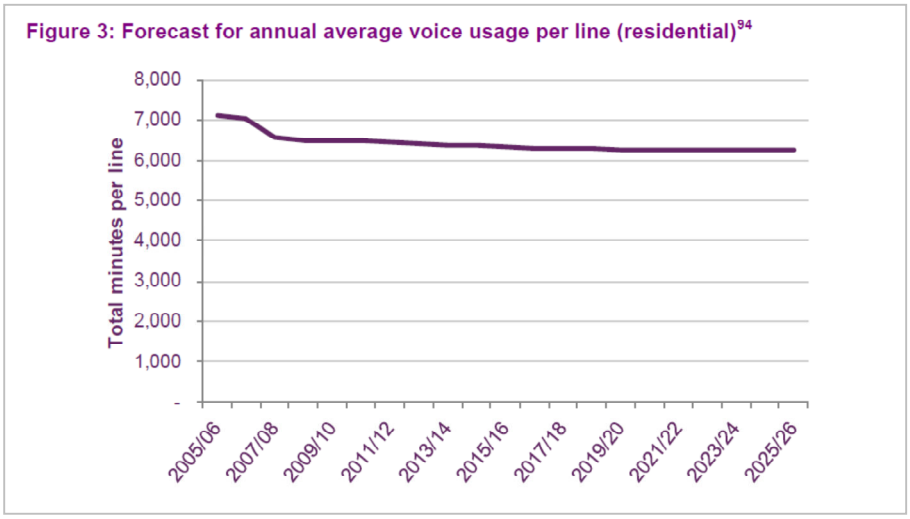
A consideration of potential alternative projections of this profile is presented in section 4.3.1 .

Originated minutes per line

Ofcom separately forecasts business and residential originated minutes per line for each type of call types, i.e. local, national, international and mobile. Summing residential and business minutes per line across all types of calls, Ofcom obtains the total minutes of originated traffic per line.

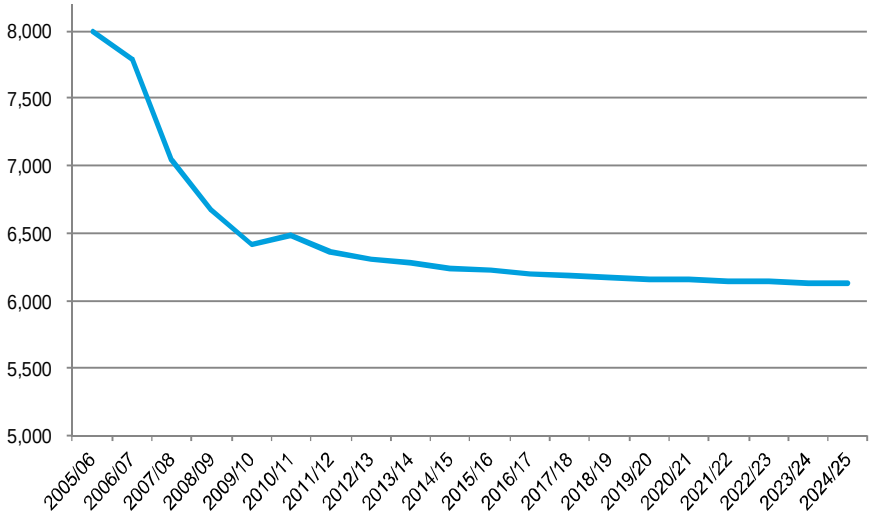
The consultation document shows[19] a graphic of the "*annual average usage per line (residential)*". The figure, however, does not match the relevant information on residential minutes per line available in the proposed NGN model. Instead, the figure appears to represent total (business plus residential) minutes per line. However, even in this case, the proposed model and the figure differ, particularly in the earlier years.

Figure 16: Voice usage originated per line (minutes), from the consultation document



Source: Ofcom, "Narrowband Market Review"; Page 32; Figure 3.

Figure 17: Voice usage originated per line (minutes), from the proposed NGN model



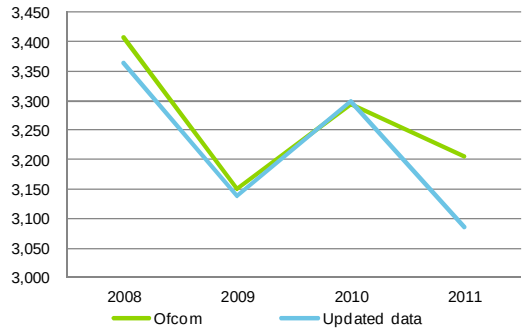
Source: Deloitte analysis based on data in the Ofcom proposed NGN model

Ofcom forecasts minutes per line (originating) based on historic data (up to 2010/11). However, more recent data (2011/12) is available from Ofcom and this additional information should be

[19] Ofcom, "Narrowband Market Review"; Page 32; Figure 3.

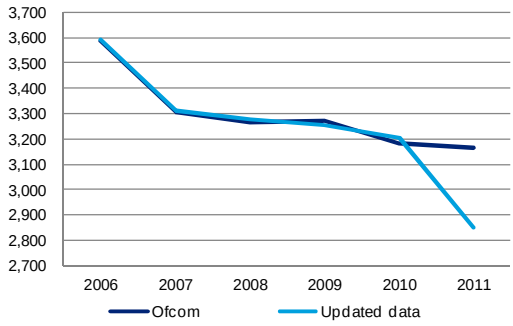
considered when constructing the volume forecasts. The figures below shows the consequence of ignoring the 2011/12 data available and are discussed in more depth in section 4.1.

Figure 18: Business call minutes per line (originating)



Source: Deloitte analysis based on data from Ofcom proposed NGN model and Ofcom 2012 Communications Market Report

Figure 19: Residential call minutes per line (originating)

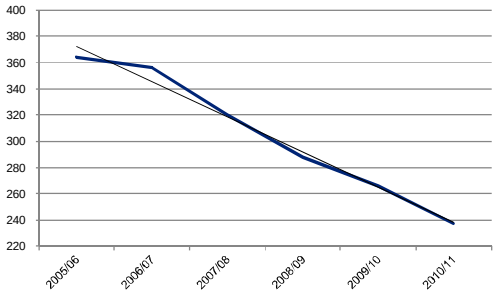


Source: Deloitte analysis based on data from Ofcom proposed NGN model and Ofcom 2012 Communications Market Report

Mobile minutes per line

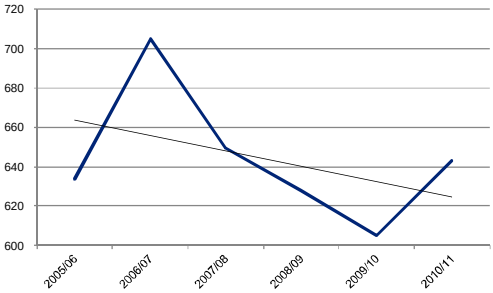
The historic trend of fixed to mobile minutes per line is decreasing, both for residential and for business. Ofcom, however, forecasts increasing business mobile minutes.

Figure 20: Residential mobile call minutes per line (historic)



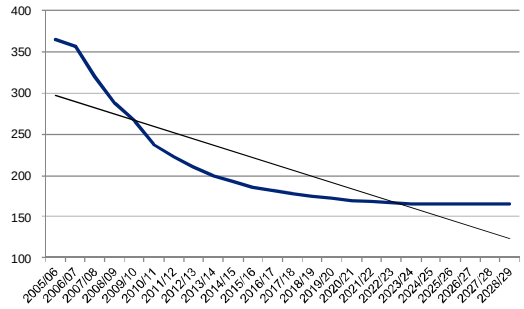
Source: Deloitte analysis based on data from Ofcom proposed NGN model

Figure 21: Business mobile call minutes per line (historic)



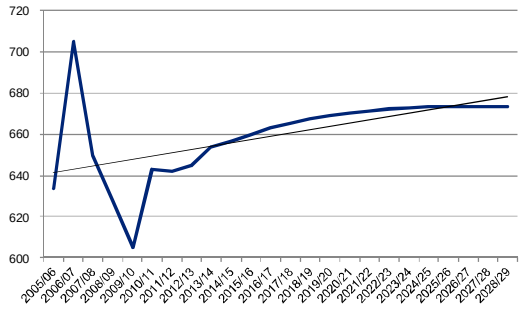
Source: Deloitte analysis based on data from Ofcom proposed NGN model

Figure 22: Residential mobile call minutes per line (Ofcom forecast)



Source: Deloitte analysis based on data from Ofcom proposed NGN model

Figure 23: Business mobile call minutes per line (Ofcom forecast)



Source: Deloitte analysis based on data from Ofcom proposed NGN model

The figures above suggest that both residential and business fixed to mobile minutes have a decreasing trend over 2005-2011. However, Ofcom's forecasts for business fixed to mobile calls show an increasing trend that is difficult to justify.

Minutes from fixed to non geographic numbers

The review of the proposed NGN model raised two concerns regarding the volume of call minutes originated from fixed to non geographic numbers:

- These minutes appear as an input in the proposed NGN model[20] but this input is not considered when calculating the total outgoing minutes.[21] The proposed NGN model calculates the total originating minutes from fixed as the sum of call minutes to local, national, international and mobile. Minutes from fixed to non geographic are not added to this calculation, despite being relevant to the estimation of the appropriate size of the proposed NGN the network.

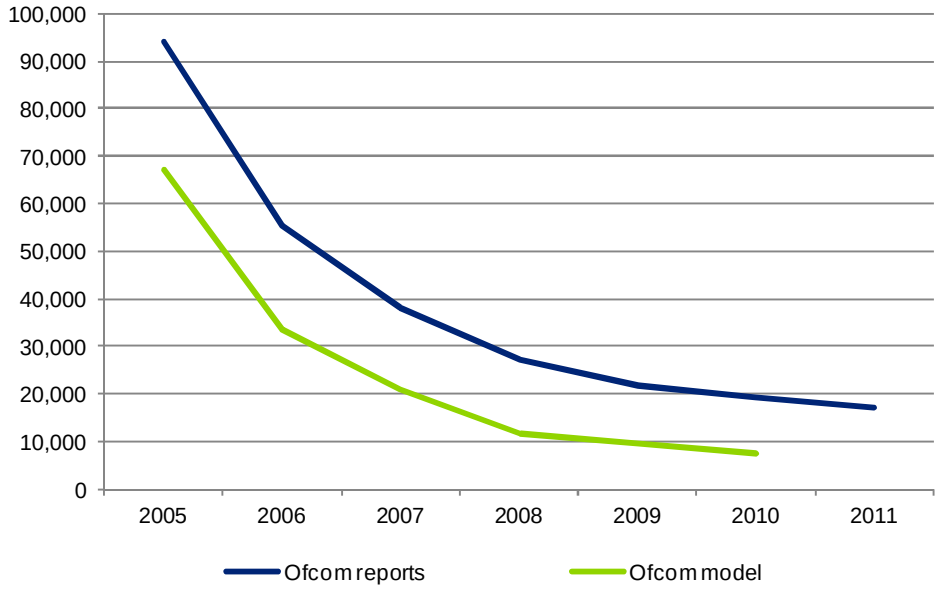
- The total number of minutes from fixed to non geographic appearing as an (unutilised) input in the Ofcom proposed NGN model does not match the information available in Ofcom's published market reports.[22]

[20] Ofcom proposed NGN model; file "Demand"; Tab "Traffic inputs".

[21] Ofcom proposed NGN model; file "Demand"; Tab "Voice and line".

[22] http://stakeholders.ofcom.org.uk/market-data-research/market-data/communications-market-reports/tables/

Figure 24: Total call minutes from fixed to non geographic numbers (millions)



Source: Deloitte analysis based on data from Ofcom proposed NGN model and Ofcom data from its market intelligence reports[23]

Conversion from outgoing minutes to incoming minutes

As introduced in section 2.1, Ofcom forecasts total outgoing minutes first.[24]

Starting from these total outgoing minutes, Ofcom recovers the number of incoming minutes, and, in a subsequent step, allocates the total (outgoing and incoming) traffic to the following categories:

- Incoming voice calls.
- Outgoing off-net voice calls.
- On-net voice calls.
- Transit.

This is done through a number of steps:

[23] http://stakeholders.ofcom.org.uk/market-data-research/market-data/communications-market-reports/tables/
For instance, see table 5 of the 2012 version of these documents. The number of minutes from fixed to non geographic numbers is not explicitly reported in these documents. However, Deloitte asked for clarifications and Ofcom explained that non geographic minutes represent 85%-90% of the category "Other calls". This is how the amounts of minutes to non geographic numbers have been constructed in by Ofcom.

[24] This is done in the file "Demand", tab "Voice and line" of the proposed NGN model.

1. Ofcom estimates the outgoing traffic to be 41% of the total (incoming and outgoing) traffic, Ofcom uses this figure to uplift the outgoing minutes and obtain the total outgoing and incoming minutes.

2. Each traffic type is assumed to correspond to a certain proportion (incoming and outgoing) of total traffic. The following table summarises Ofcom's assumptions on this regard:

Table 3: Assumed proportions of total (outgoing and incoming) traffic, by traffic type

Traffic category	Proportion of total (outgoing and incoming) traffic
On-net NGN calls (single aggregation node)	37%
On-net NGN calls (cross core)	24%
Off-net incoming calls (national single aggn node)	61%
Off-net outgoing calls (national single aggn node)	41%
Off-net incoming calls (national cross core)	12%
Off-net outgoing calls (national cross core)	24%
Off-net incoming calls (international)	2%
Off-net outgoing calls (international)	2%
On-net Legacy to NGN calls	0%
On-net NGN to Legacy calls	2%
Transit calls (single aggregation node)	24%
Transit calls (cross core)	12%
On-net Legacy to Legacy calls	0%

Source: Ofcom proposed NGN model

3. These proportions are then reduced to account for the fact that in years prior to 2014/15 the transition from PSTN to NGN is not yet complete.

4. Finally, the minutes for each category of traffic are obtained by multiplying total (incoming and outgoing) traffic by the corresponding calculated proportion of total traffic.

This method raises a number of concerns:

- Given the asymmetric nature of the outgoing and incoming traffic between fixed and mobile, this methodology does not seem to be the most appropriate to capture minutes from mobile to fixed. It would appear appropriate to also produce direct forecasts of "mobile to fixed" minutes.

- It is a rather convoluted approach to forecasting traffic and makes it difficult to reconcile traffic forecasts back to Ofcom's market report. A more transparent approach would be to expand the number of call types in the demand module and to enter the traffic forecasts directly. .

2.3.3 Ofcom's broadband forecasts

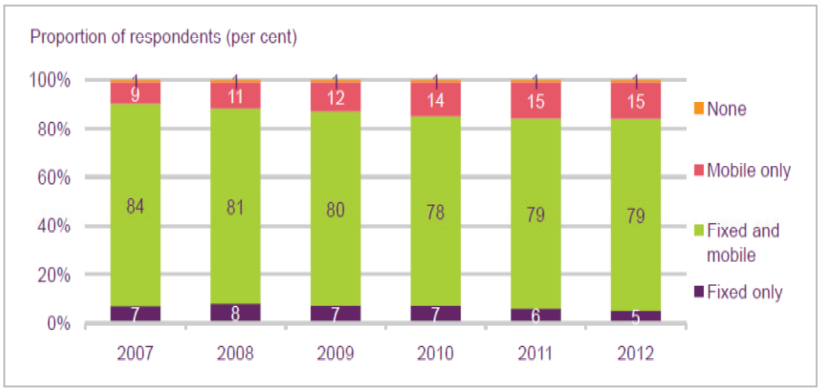
Broadband penetration

Ofcom's current forecasts of the number of broadband lines are such that in 2022/23 a maximum household broadband penetration of 84.5% is reached[25]. No discussion is provided as to why household broadband penetration (approximately 75% in 2010/11) should reach 84.5% in the future.

Ofcom's 2012 Communications Market Report[26] provides the following information:

- In 2012, 80% of UK households have both a fixed and a mobile connection. This percentage shows a decreasing trend over time.
- In 2012, 5% of UK households have a fixed connection only. This percentage shows a decreasing trend over time.

Figure 25: Household penetration of fixed and mobile telephony



Source: Ofcom 2012 Communications Market Report, Figure 5.56

Based on an extrapolation of the the decreasing trend of the percentage of households having a fixed connection (see Figure 25), the above trend does not appear likely to achieve a level above 82% in the longer term.[27]

Broadband bandwidth

The historic trend of broadband bandwidth is increasing but at a *decreasing* rate. Ofcom, however, assumes that broadband bandwidth will continue to grow until 2025. Ofcom does not provide any justification for the increasing growth figure which appears optimistic when compared to an extrapolation of existing trends..

[25] Calculation based on data on the number of residential broadband lines and the number of households in Ofcom proposed NGN model (file "Demand").

[26] Figure 5.56.

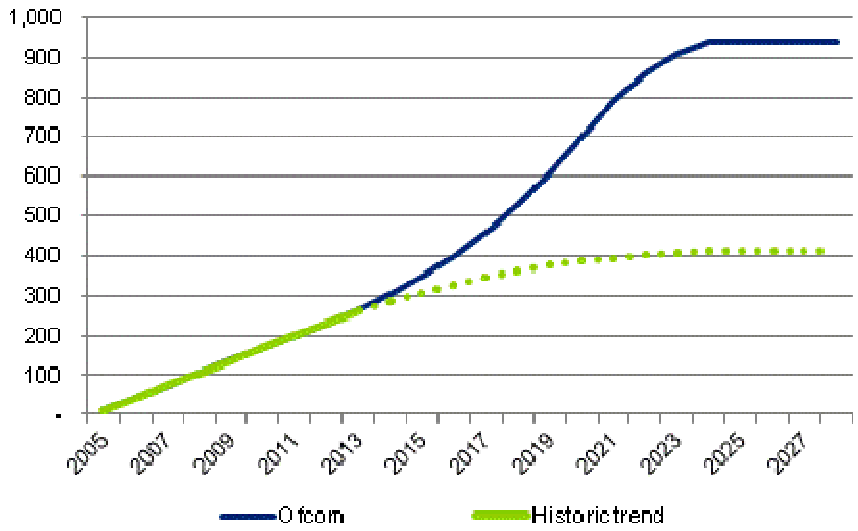
[27] This figure is an extrapolation by Deloitte based on the decreasing trend of the percentage of households having a fixed connection (reported in Figure 25).

Table 4: Ofcom's assumed rate of growth of broadband bandwidth

2011/12 – 2020/21	2021/22	2022/23	2023/24	2024/25	2025/26 – 2045/46
15%	12%	9%	6%	3%	0%

Source: Ofcom proposed NGN model

Figure 26: Broadband bandwidth per line (Kbit/s)



Source: Ofcom proposed NGN model and Deloitte extrapolation of historic trend

Ofcom does not provide separate forecasts for copper and fibre based broadband. However, demand for fibre broadband penetration is likely to increase faster than copper based broadband as consumers demand higher bandwidth and faster services.

As data that is delivered over fibre broadband is likely to be lifted off the network at the cabinet, there will be less data traffic on the network than is assumed by Ofcom and a higher proportion of the network costs would therefore be allocated to voice products, including the FTR.

3 Impact of changing technology and consumer preferences

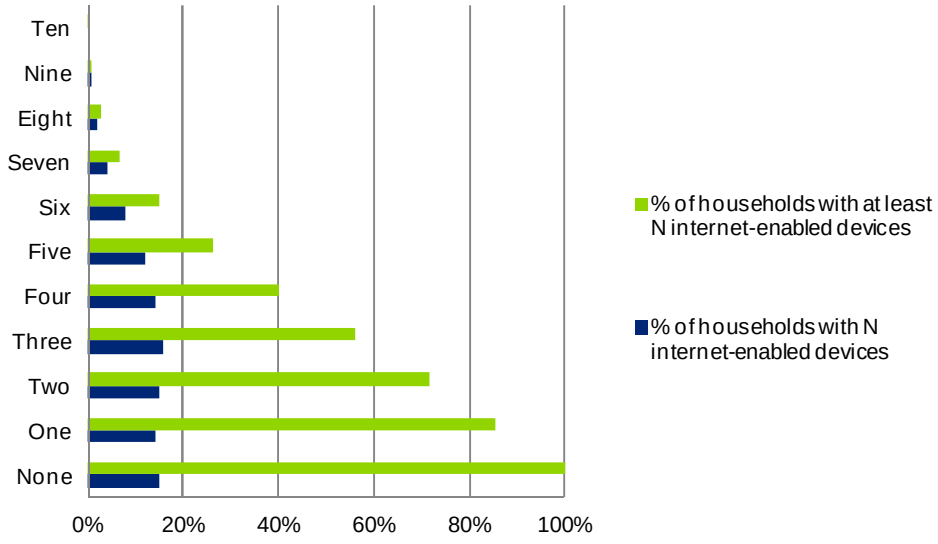
As consumer preferences continue to evolve, supported by technological advances, service demand can be expected to change in the future. As such these trends need to be considered within Ofcom's volume forecasts in the proposed NGN model and are considered in this chapter.

3.1 The future of fibre based broadband

Customers will increasingly require fibre based broadband to meet their service needs. Households will have multiple devices and some of these will have high download requirements:

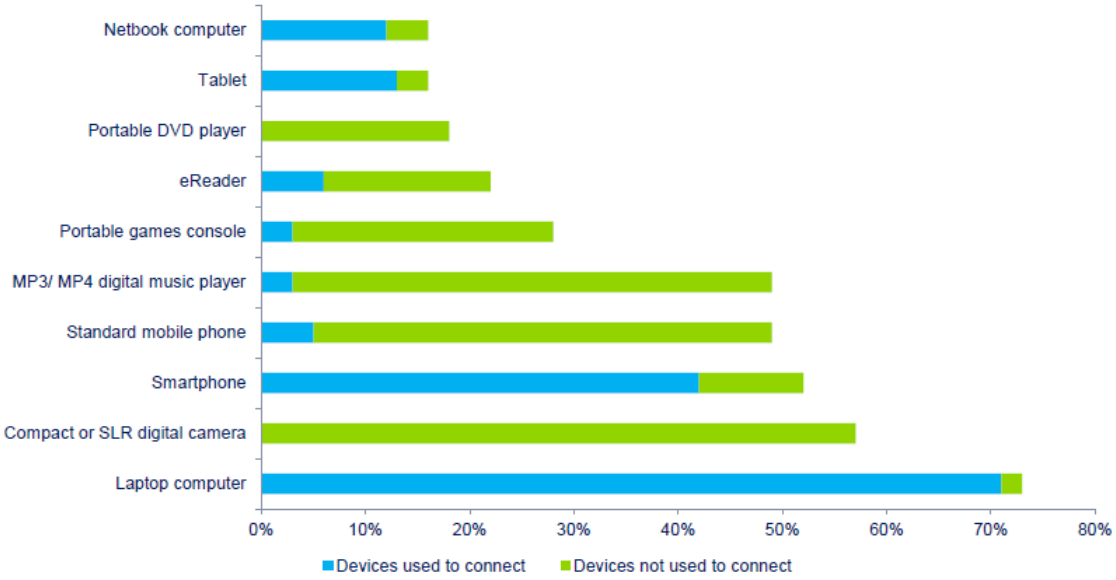
- Many households are expected to use more than one IP-enabled handset over Wi-Fi. Tablets, smart-phones, laptops and smart TVs will require a larger bandwidth. The size of data that needs to be transferred and stored is continuously increasing. Furthermore, mobile Internet usage from mobile phones is moving to the Wi-Fi network, as users connect mobile devices to Wi-Fi.

Figure 27: Number of internet-enabled devices per household



Source: Ofcom research, Quarter 1 2012. Note: IP-enabled devices include laptop, games console, desktop PC, smartphone, portable games console, internet enabled STB (Sky+, Sky+ HD, V+ and V+ HD set top boxes), e-reader, tablet, netbook, and smart TV.

Figure 28: Devices owned, split by those connected to the internet (UK)



Source: Deloitte Global Mobile Consumer Survey, UK data, May 2012.

- The content of websites, and the size of applications and software is constantly increasing. Videos and photo resolution have reached HD standards and are now heading towards Ultra-HD levels. To stream an HD-resolution video requires 4Mbit/s connectivity. Fibre will be needed to support this larger amount of data, especially considering that the UK average broadband speed in the second half of 2011 was between 1 and 5 Mbit/s.[28] Websites are becoming more complex; In 2011, on average[29], websites have increased their content by about 25% and this trend is likely to continue.[30]

- Digital cameras appear likely to increasingly use Wi-Fi and take-up will increase due to expected price declines. While the proportion of tablets, smartphones and laptops connected to the internet is significant, further bandwidth requirements will arise as internet connectivity will become more popular on digital cameras. The resolution and the size of the photos of digital cameras are also increasing, as illustrated by the fact that it is now possible to purchase a 240GB SD card and the highest quality digital cameras available on the market can now reach 80.1 MP. Uploading these photos on social media, such as Instagram, which hit 7.3 million mobile daily users in August 2012 in the US[31], or Facebook will require additional bandwidth.

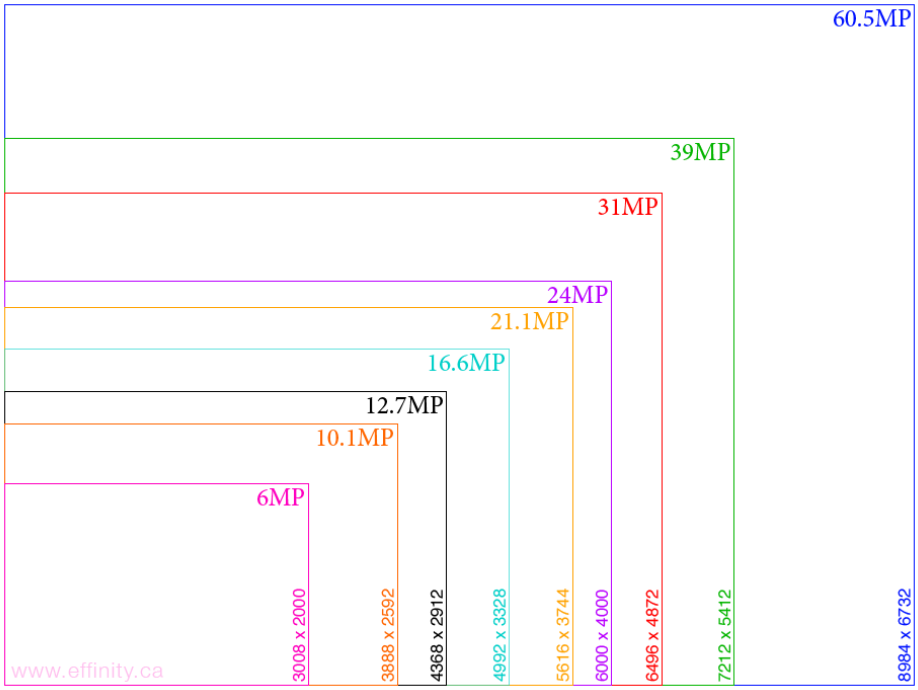
[28] http://stakeholders.ofcom.org.uk/market-data-research/other/telecoms-research/broadband-speeds/bb-speeds-nov-11. This data refers to the 25th to 75th percentile 'typical speed range' for those with an ADSL connection of 'up to' 8Mbit/s.

[29] Average calculated among the 1000 websites on which internet users have spent the highest amount of time overall.

[30] http://royal.pingdom.com/2011/11/21/web-pages-getting-bloated-here-is-why/

[31] http://allthingsd.com/20120927/instagram-beats-twitter-in-daily-mobile-users-for-the-first-time-data-says/. The article refers to the Mobile Metrix comScore report.

Figure 29: Digital Camera Resolution Comparison Chart



Source: istockphoto.com

- Larger and higher-resolution televisions appear likely to continue to be produced. 4K Ultra HD TVs are expected to be produced by 2014 which have four times the high definition resolution of a standard HD TV. 8K TVs, with sixteen times the resolution of a standard HD TV, are expected to be available by 2020.[32] 8K television has bandwidth requirements that cannot be handled by the current networks and as such producers do not expect it to be available to the public before 2020 when a higher proportion of consumers have fibre based broadband.

- Piracy is one of the main drivers of internet traffic. Two recent take-downs, Megaupload and Pirate Bay, indicate the scale of this issue:

    - Total Internet traffic dropped between 2 percent and 3 percent during the hour following the FBI raid against Megaupload on January 18.[33]

    - Immediately after a ban was enforced on Pirate Bay's network, the ISPs said P2P activity had dropped by over 11% compared to average levels.[34]

[32] 4K refers to one of two high definition resolutions: 3840 x 2160 pixels or 4096 x 2160 pixels. 4K resolution is now being employed in an increasing basis in commercial digital cinema projections.

Also, 4K, under its official consumer label, Ultra HD, is beginning to be implemented into the home theatre environment via both a growing number of home theatre receivers that have either 4K pass-through and/or 4K video up-scaling capability, as well as some 3D-TVs and 3D video projectors.

[33] http://www.digitaltrends.com/web/study-finds-internet-piracy-resilient-despite-megaupload-takedown/

[34] http://www.bbc.co.uk/news/technology-18833060

The two main activities of downloading and streaming of large and growing files may create congestion issues. To tackle this problem, fibre based broadband is likely to be necessary.

- Cloud storage, remote working and outsourcing are the main trends in business-to-business. These activities will require a larger bandwidth, as they rely on a fast and reliable connection. For example, Virtual Desktop Infrastructure (VDI) and thin client hardware are solutions adopted by an increasing number of firms. VDI allows having the personal desktop including files and software stored on a remote server that can be accessed from anywhere. Thin client hardware, instead, are devices that are supported by software stored on remote servers. Citrix's XenDesktop is an example of these VDIs, Citrix also collaborated with WYSE (now Dell WYSE) in the development of the first thin client hardware in 2005. In the office environment, printing and the use of remote printers may further increase the need for broader bandwidth.

- On-line gaming is another activity that requires large quantity of bandwidth. The instantaneous interaction of many players can quickly exhaust the entire bandwidth, particularly as games become bigger in size (growing from 2GB to 20GB on average over the last 10 years).

The ongoing and expected further increases in consumers' bandwidth requirements are being reflected by BT and other operators. Average broadband speed increased by 19% year on year[35] and reach of superfast Internet has expanded to 8% of homes compared to 5% six months ago.[36] BT plans to reach more than 60% of the population with high speed broadband by 2015.

3.1.1 Forecasts and further analysis

In June 2010, Ofcom published its consultation on the review of the wholesale broadband access (WBA) markets. In this document Ofcom expressed several opinions pointing towards the deployment of fibre. Ofcom advocates the development of an NGA (New Generation Access) network able to deal with an increasing demand for bandwidth. The technology required for this network encompasses fibre (FTTC and FTTP), upgrades to cable and VDSL.

Ofcom lists several applications and activities that will require an increasing amount of bandwidth.

- Everyday activities carried out by internet users are cited as downloading and uploading of files, voice and video communication, e.g. Skype, and watching live and catch-up TV.

- TV manufacturers have been introducing Ethernet ports directly on TVs, while game consoles were already able to connect to the internet since 2008. "*Families appear likely to use several devices connected to the internet simultaneously. For example, streaming high definition content in the living room on a TV at the same time as on a computer in the bedroom during the evening peak times would require at least a 30Mbit/s to 40Mbit/s connection, most likely higher to take into account contention with other users and distance*

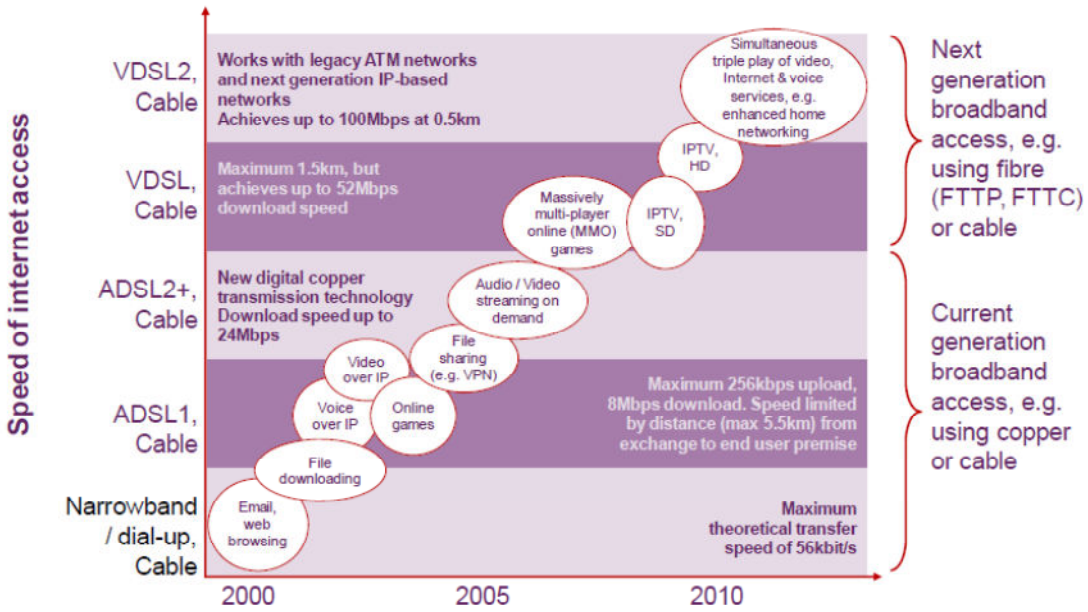
[35] Ofcom's Communications Market Report, 2012. The increase is from the 2011 level.

[36] BBC, 2012. Superfast is here defined as delivering internet download speed of 25Mbit/s+. The increase is from the 2011 level.

from the exchange. The delivery of such services necessarily depends on the availability of next generation broadband access."

- Businesses are also likely to demand increasing bandwidths. Usage of centralised file sharing accessed via virtual private networks (VPNs) will allow employees to work remotely. Other activities mentioned by Ofcom, that can increase bandwidth requirements, are video conferencing, remote monitoring and surveillance.

Figure 30: Services enabled by current and next generation broadband access



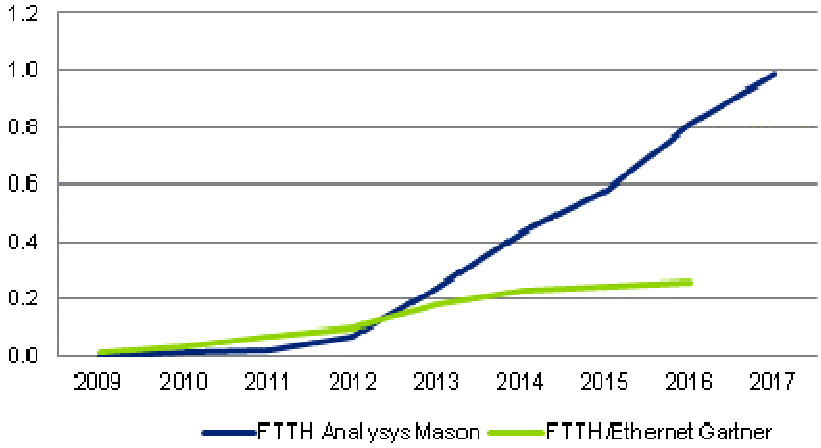
Source: Ofcom Review of the wholesale broadband access markets, 2010

Analysys Mason[37] and Gartner[38] also support the increase in fibre use, as demonstrated in the following diagram.

[37] Analysys Mason: Telecoms Market Trends and Forecasts 2012-2017.

[38] Gartner. "Forecast: Consumer Fixed Voice, Internet and Broadband Services, Worldwide, 2009-2016, 3Q12 Update"

Figure 31: Number of FTTH subscriptions (millions)



Source: Analysys Mason and Gartner

Budde Communication does not predict fibre deployment separately from cable, but states that it is fibre broadband that will drive further broadband take-up.[39]

3.2 LTE technology (4G)

The deployment of LTE technology will enable people to connect at a high speed from their mobile devices using the mobile network. The LTE network upgrade is expected to provide consumers with mobile data speeds up to 20 times faster than currently available on 3G and with faster response times.

Everything Everywhere (EE) introduced LTE technology in some cities from October 2012 and Three is expected to launch this technology in December 2012. From January to June 2013 all other operators will have the opportunity to purchase part of the spectrum made available for LTE. In 2-3 years the coverage is expected to reach around 95% of the population. In the near future, this technology may potentially attract a huge quantity of internet traffic. In recognition of the impact of LTE, Cisco's forecasts mobile data traffic in the UK:

- Grow 12-fold from 2011 to 2016, a compound annual growth rate of 65%. Mobile data traffic will grow 2 times faster than UK fixed IP traffic from 2011 to 2016.

- Account for 10% of UK fixed and mobile data traffic in 2016, up from 3% in 2011. Mobile data traffic in 2016 will be equivalent to 5 times the volume of the entire UK Internet in 2005.

An economic impact study of LTE technology was recently published by Capital Economics.[40] This study cites several forecasts of growth rates for mobile data traffic being up to 125% pa. However,

[39] Paul Budde Communication Pty Ltd (2012): "United Kingdom – Broadband – Fixed network Statistics and Forecasts". Budde produced only forecasts for the years 2011, 2012 and 2020. Interpolation between 2012 and 2020 is Deloitte's analysis.

[40] http://www.4gbritain.org/wp-content/uploads/2012/04/Mobile-Broadband-and-the-UK-Economy-30-April-2012.pdf

the report by Capital Economics has a more conservative view of 35% growth up to 2015 as a result of the expected complete roll-out of LTE technology within this timeframe. It should be noted, however, that although LTE may increase mobile data levels, it will not necessarily substitute from fixed as many consumers are still expected to use their mobile devices over Wi-Fi.

4 Developing of alternative volume projections

BT has requested that we use a review of third party forecasts and a review of Ofcom's approach to develop a set of alternative volume forecasts. These are intended to be illustrative based on the information available to us. We would recommend that Ofcom undertakes further analysis and revises its volume forecasts accordingly.

This chapter presents an alternative set of projections which have been constructed for the purpose of allowing an informed debate over the volume forecasts within the proposed NGN model. These projections are presented in section 4.2 and make use of three categories of new information.

- Use of 2011/12 data.
- The impact of evolving technologies and changing consumer preferences.
- Consistency with available third party forecasts.

The assumptions within the proposed NGN model which appear to have the greatest impact on the model and which are therefore the focus of this chapter are:

1. Voice versus data traffic, since only voice traffic can be incremental in an FTR calculation.
2. Fibre versus copper broadband since only copper broadband traffic uses the NGN network alongside voice.
3. Absolute amount of voice traffic, since once fibre broadband traffic is removed this becomes the main driver of network capacity equipment.

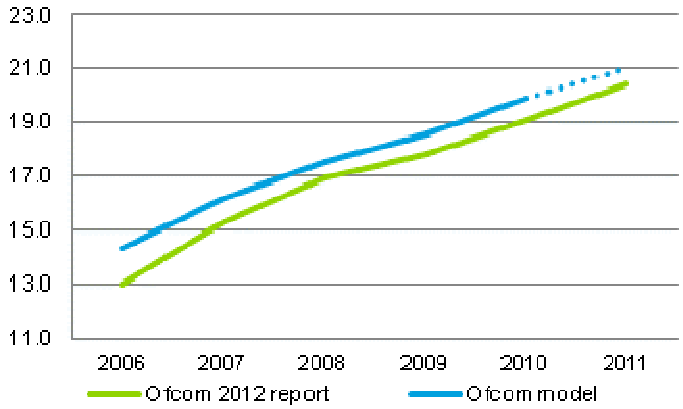
It is recommended that Ofcom undertakes further analysis into the volume forecasts in the proposed NGN model on the basis of the issues identified.

4.1 Ofcom's recent market intelligence report

As discussed in section 2.2.1, Ofcom does not utilise the information available in its 2012 Communications Market Report.

In the case of broadband lines, Ofcom not only ignores the 2011/12 data available, but also employs inputs in the model which differ from the number of broadband lines which appear in the 2012 Communication Market Report.

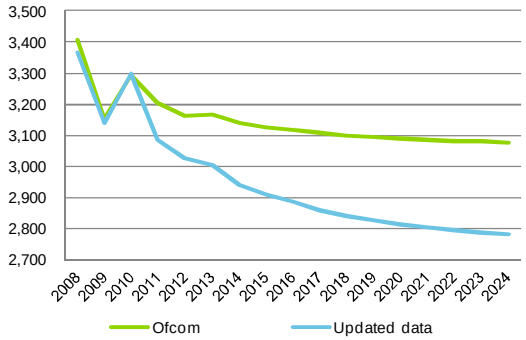
Figure 32: Number of broadband lines (millions)



Source: Ofcom proposed NGN model and Ofcom 2012 Communication Market Report

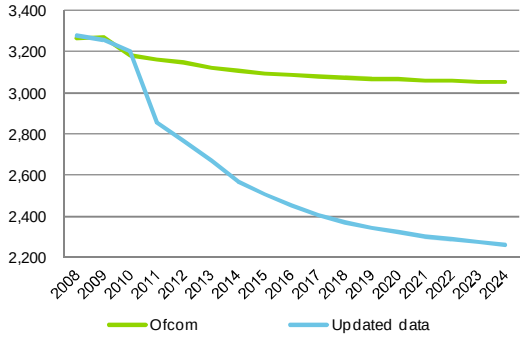
For the call minutes per line, revising Ofcom's forecasts to account for the 2012 information available leads to lower levels of volumes in later years.

Figure 33: Business total call minutes per line



Source: Deloitte analysis based on data from Ofcom proposed NGN model and Ofcom 2012 Communications Market Report

Figure 34: Residential total call minutes per line



Source: Deloitte analysis based on data from Ofcom proposed NGN model and Ofcom 2012 Communications Market Report

4.2 Third party sources

There are a number of volume forecasts available from third party sources which are not referenced within the consultation or utilised within the proposed NGN model.

4.2.1 Gartner and Budde Communication Pty

In mature markets, Gartner predict that:

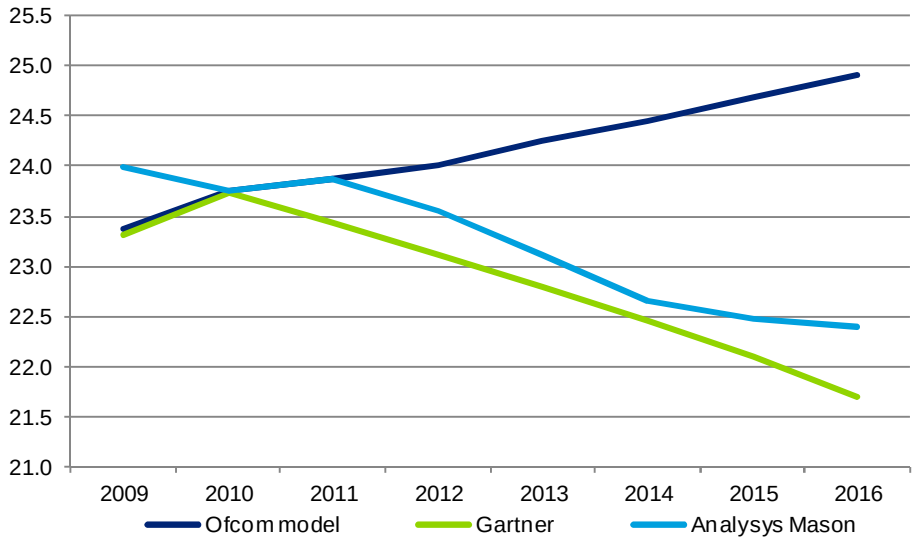
- The number of fixed voice lines/channels will decline in the longer term.

- By 2016, 72% of households in mature markets will have a fixed voice telephony line, down from 100% in 2005.

Mobile connections and peer-to-peer VoIP calling are seen as replacing legacy fixed voice services in mature markets. Gartner also reports that in some countries such as Mexico, the UK, Germany, Malaysia, India and Indonesia, broadband connections are sold with fixed voice line connection. As such, consumers will retain their legacy lines and will use less minutes over these lines.

The following graph presents alternative forecasts from third parties alongside the forecast contained in the proposed NGN model.

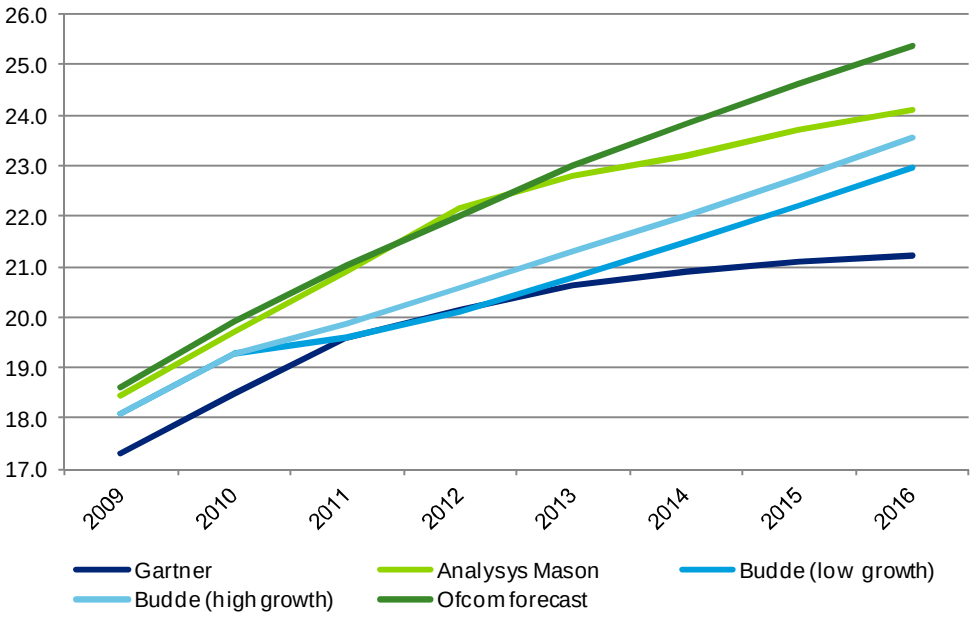
Figure 35: Number of residential voice fixed lines (millions)



Source: Ofcom proposed NGN model, Analysys Mason and Gartner

Gartner stresses that in the UK (and in a number of other countries) broadband lines connections must be sold together with fixed voice lines connections. While recognising this point, Gartner predict a strong decline in fixed lines and an increase in broadband lines at the same time. This is due to the fact that as dial-up connections are substituted with broadband lines and consumers use more and more mobile voice traffic, fixed voices lines are decreasing.

Figure 36: Number of broadband lines (millions)



Source: Ofcom proposed NGN model, Analysis Mason, Budde Communication and Gartner

Budde produces two scenarios for the broadband market, reflecting high and low growth in broadband subscribers. The rationale for the difference between these two scenarios is the development of fibre.

In the higher growth scenario, Budde assume that legacy copper will be replaced by fibre to a great extent. In the lower growth scenario, fibre is forecast to grow more slowly, as users are assumed to present a lower demand for faster services. However, growth is still driven by products such as Video-on-Demand (VoD), Internet Protocol TV (IPTV) and Voice over Internet Protocol, which will become very popular.[41]

In summary, alternative broadband forecasts are mostly lower than Ofcom's forecasts within the proposed NGN model and analysts note that much of the growth will be driven by fibre broadband. This is a particularly important conclusion, since Ofcom does not currently forecast copper and fibre broadband separately nor recognises two different network configurations that arise as a result.

4.3 Adjusted volume projections

In this section we propose a set of alternative set of projections which have been constructed for the purpose of allow an informed debate over the volume forecasts within the proposed NGN model. As noted above, these projections are developed in the light of:

[41] Budde produced only forecasts for the years 2011, 2012 and 2020. Interpolation between 2012 and 2020 is Deloitte's analysis.

- The most recently available date.
- The impact of evolving technologies and changing consumer preferences.
- Consistency with available third party forecasts.

4.3.1 Voice/ISDN

In this section we seek to adjust Ofcom's forecasts based on alternative forecasting approaches and third party analysis.

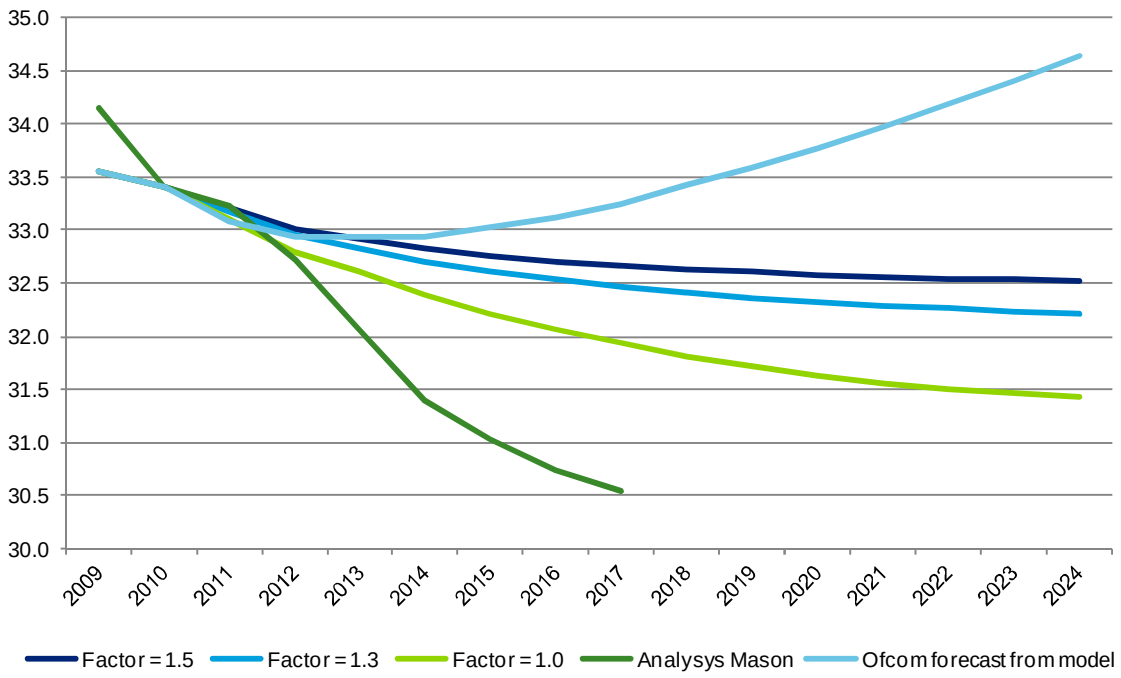
Number of lines / channel

Ofcom's forecast for the total number of line/channels shows a counterintuitive U-shaped trend, as discussed in section 2.3.2.

Two specific changes, in addition to taking account of third party forecasts, would improve the quality of the projection of the total number of lines / channels:

- Forecasting total lines directly as opposed to lines per household or per business. This approach is more successful in capturing the decreasing historic trend in the total number of lines and removes the counterintuitive U-shaped trend in the number total lines forecast by Ofcom.
- Adjust the dampening factor to reflect the decreasing trend in lines and the expectation that new households will have a lower adoption of fixed lines compared to the stock of households.

Figure 37: Projections of total lines and channels (millions)



Source: Deloitte analysis based on data from Ofcom proposed NGN model and Analysys Mason; The Deloitte projections based on Ofcom data are presented for three different values of the dampening factor

This adjustment leads to a continuation of the downwards trend visible in earlier years and is more in line with the forecasts produced by Analysys Mason and others.

Originated minutes of use

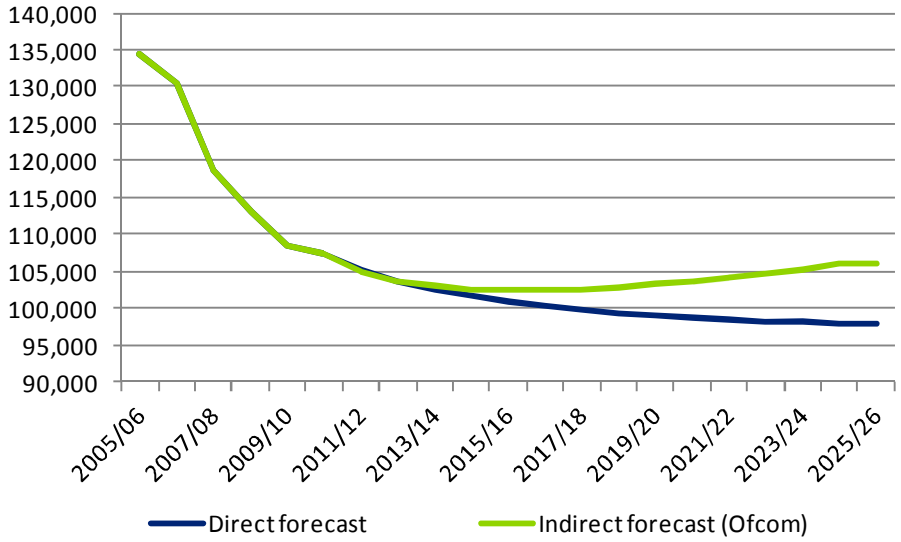
There are two possible approaches to forecasting total minutes of use originated:

1. To directly forecast the total minutes of use based on historic data, i.e. a direct forecast.

2. To forecast the minutes of use *per line* and then to obtain total usage by multiplying minutes per line times the forecast of the number of lines, i.e. an indirect forecast.

The figure below shows a comparison of the forecasts contained within the proposed NGN model (which adopts the second approach) with projections obtained by adopting the first method.

Figure 38: Projection of the total minutes originated (millions)

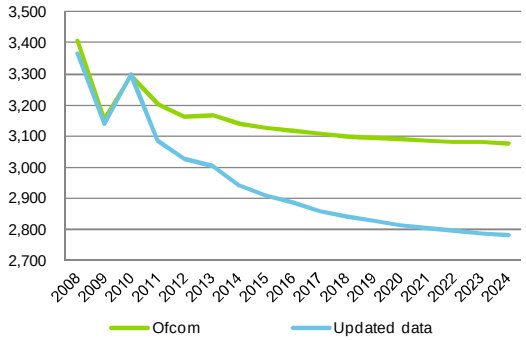


Source: Deloitte analysis based on data in Ofcom proposed NGN model

The direct projection appears to better extrapolate the past trend in total minutes of use. The U-shaped trend produced by the proposed NGN model is driven by the total number of lines forecast by Ofcom, which itself has a counterintuitive U-shaped trend as discussed in section 2.3.2.

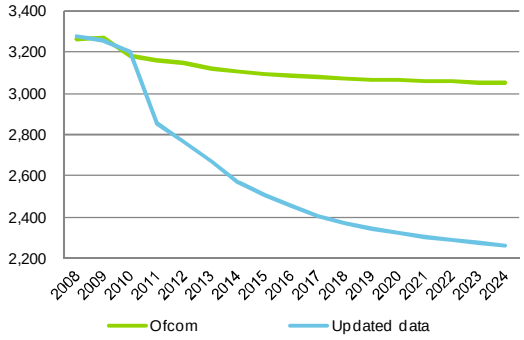
Even if Ofcom's decided to adopt the first method, it should update its analysis to account for the 2011/12 data which is now available (see section 2.3.2). The resulting forecast minutes originated per line is displayed below. Ofcom's forecasts about the 2011/12 minutes per line appear to be too optimistic compared to the actual values reported in its 2012 Communications Market Report and this difference gets further compounded over time.

Figure 39: Projections of business total call minutes per line (originating)



Source: Deloitte analysis based on data from Ofcom proposed NGN model and Ofcom 2012 Communications Market Report

Figure 40: Projections of residential total call minutes per line (originating)



Source: Deloitte analysis based on data from Ofcom proposed NGN model and Ofcom 2012 Communications Market Report

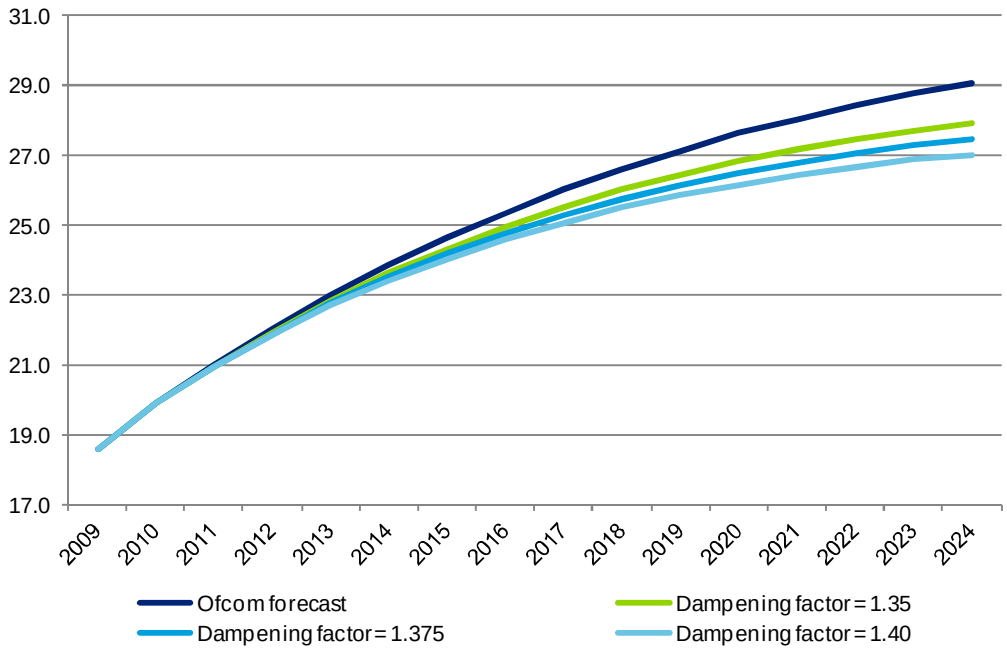
4.3.2 Broadband

Broadband penetration

In the proposed NGN model, Ofcom forecasts broadband penetration to reach 84.5% in 2025. This appears too optimistic, as discussed in section 2.3.3. In the following diagrams, we provide an alternative profile for the number of broadband lines and the corresponding levels of broadband penetration.

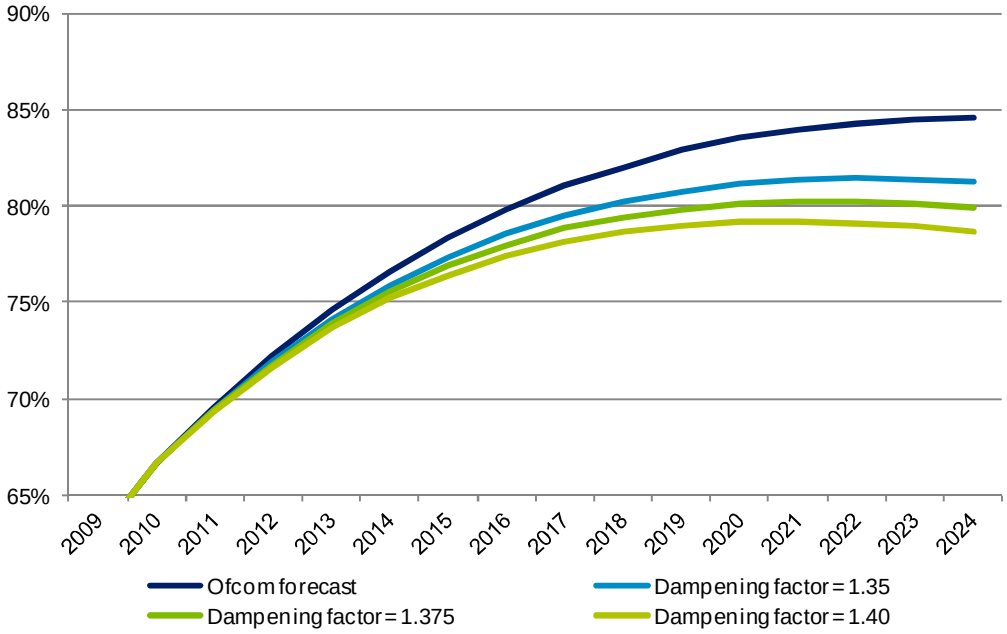
These projections are more in line with evidence from Ofcom (see Figure 25) suggesting that in the longer term the penetration of fixed broadband is unlikely to be higher than 82%.

Figure 41: Projection of total number of broadband lines (millions)



Source: Deloitte analysis based on data from Ofcom proposed NGN model; The Deloitte projections based on Ofcom data are presented for three different values of the dampening factor

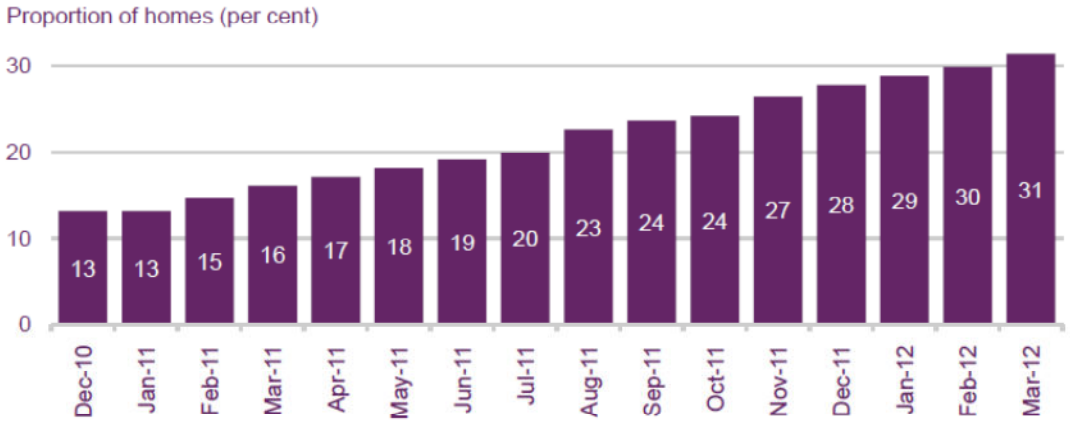
Figure 42: Projection of household penetration of broadband



Source: Deloitte analysis based on data from Ofcom proposed NGN model; The Deloitte projections based on Ofcom data are presented for three different values of the dampening factor

In addition to the decreasing trend in household penetration, Ofcom's forecasts should take into account the relative proportion of fibre to copper based broadband. Ofcom currently forecasts only the total number of broadband lines, without explicitly modelling the substitution process in act between fibre and copper. Ofcom's data on the household availability of FTTC shows that fibre is rapidly becoming available to an increasing segment of customers. This portion is expected to greatly increase as consumers will further require fibre based broadband to meet their service needs.

Figure 43: Estimated household availability of BT's FTTC network



Source: Ofcom 2012 Communications Market Report

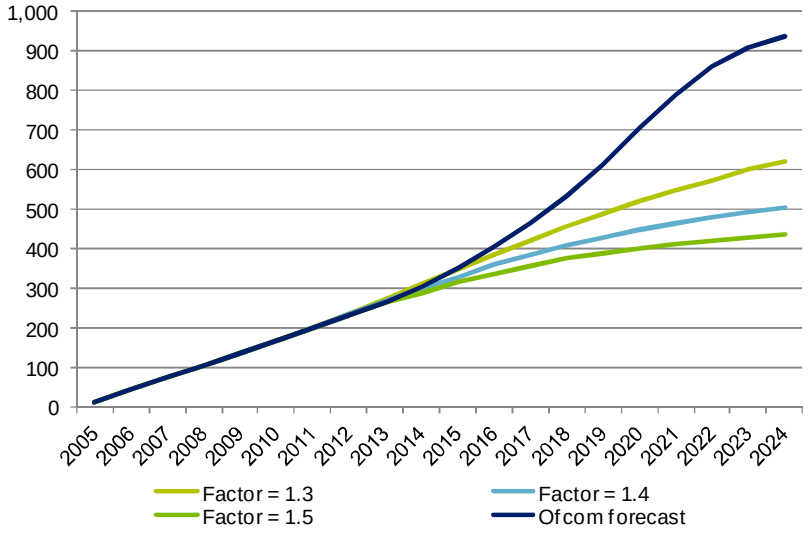
Third party analysts, such as Budde Communication, while not explicitly predicting fibre deployment separately from cable, do predict that it will be fibre rather than copper the major driver of broadband take-up.[42]

Overall, given the important changes occurring in the deployment of broadband networks, Ofcom's analysis on the future of total broadband deployment could benefit from an explicit discussion of / allowance for the role that copper and fibre will have within the general trend.

Broadband bandwidth

As discussed previously, Ofcom's bandwidth forecast is not in line with the historic trend in bandwidth growth. This leads to a potentially optimistic increase in broadband bandwidth that is adjusted in the following projections.

Figure 44: Projection of broadband bandwidth per line (Kbit/s)



Source: Deloitte analysis based on data from Ofcom proposed NGN model; The Deloitte projections based on Ofcom data are presented for three different values of the dampening factor

Whilst outside the scope of this report , an explicit modelling of the relative proportion of fibre to copper based broadband is likely to be important to understand future bandwidth requirements.

The ongoing and expected further increases in consumers' bandwidth requirements are being reflected by BT and other operators. Average broadband speed increased by 19% year on year between 2011 and 2012 and BT plans to reach more than 60% of the population with high speed broadband by 2015.

The growth rate of bandwidth forecast by Ofcom (Table 4) suggests that Ofcom expects broadband bandwidth requirements to display a steady growth until 2010/21, despite a decreasing growth rate

[42] Paul Budde Communication Pty Ltd (2012): "United Kingdom – Broadband – Fixed network Statistics and Forecasts". Budde produced only forecasts for the years 2011, 2012 and 2020. Interpolation between 2012 and 2020 is Deloitte's analysis.

over 2005-2010. This assumption can be related to the above discussion of the expected increasing consumer demand for bandwidth and the ongoing substitution of fibre for copper based broadband. However, given that no explicit attempt is provided by Ofcom to model the substitution between fibre and copper, the assumed growth rates for broadband bandwidth appear, at the moment, out of context.

5 Technical review of volume based assumptions

This chapter provides a review of the network structure and assumptions in the proposed NGN model. In particular, the review focuses on the extent to which the dimensioned network is capable of providing the level of service required to meet the volume forecasts provided.[43] The chapter sets out a number of calculations and assumptions that Ofcom and its advisors could reconsider during the consultation process.

5.1 Call demand and network dimensioning

In paragraph 4.4 of the proposed NGN model documentation, it is stated that "*The network is dimensioned to be able to carry the traffic that occurs during the busy hour*". However, documentation does not provide a detailed explanation of how the network is dimensioned to be able to carry the traffic and the calculations within the model are hidden.

While the proposed NGN model documentation states that the busy hour traffic is used for network dimensioning, the CCITT standard assumes a mean of 30 peaks, whilst in reality the peak of peaks has to be carried at the required Grade of Service in the busy hour.

The model dimensions the network to meet the busy hour traffic. As such, it follows that the modelled network will not be able to carry the peak of peak traffic at the required Grade of Service. To address this issue, Ofcom could consider including a factor (of scale of 8%) in the epc calculation to allow for the 'peak to average' capacity requirements.[44]

There are a number of features included in BT's TDM network, which increase the probability of a call being successful (the meshed network design, the use of Automatic Alternative Routing and the triple parenting of DLEs) and which are required to deliver 1% overall network GoS. In BT's design for 21CN the Core Nodes are fully interconnected, providing a connectionless core IP network where any call can use any available path across the Core. The model proposed here is of five rings connecting 8 inner and 12 outer nodes, which costs less as there are fewer transmission routes, but it does mean that two failures in the core can isolate parts of the country from other parts, which is not true of either of the BT network designs.[45] The proposed model costs less, but does not offer the same level of resilience as BT's networks.

The proposed NGN model assumes 1.1 call attempts per successful call suggesting 1 in 11 calls are unsuccessful. It is understood that BT's current network is dimensioned to ensure only 1 in 100 (1%) calls are lost in the busy hour and no more than 1 in 200 calls overall (24/7). As such, the proposed NGN model appears to understate the amount of equipment required to meet today's level of service.

The measure of calls not being carried on a transmission link due to capacity not being available is the grade of service (GoS). Switch capacity should be dimensioned to ensure no call fails due to lack of switch capacity. The probability of a call not succeeding, customer to customer, due to

[43] This review has been limited by the time available and it is likely that there are other areas of the model that require further consideration.

[44] As proposed previously by the Oftel TG13 Study Group.

[45] It is unclear from a review of the proposed NGN model and documentation whether this is included.

designed GoS is dependent on its value and the number of links in a call path. This measure is known as the end-to-end GoS. Transmission capacity is about delivering the required Grade of Service with the minimum amount of network. This requires an appreciation of the physical network structure including whether switches are co-located or remote. These assumptions regarding the GoS route dimensioning for BA-SA, SA-CN, CN-CN and CN-CP routes to achieve an end-to-end GoS <1.0% should be explicitly considered by Ofcom.

Section 4.4, of the NGN model documentation states that in order to use the traffic forecasts expressed in minutes for network dimensioning, the traffic is converted into busy hour megabits per second (BH Mbit/s). A number of factors need to be addressed in converting the figures in the erlang table in the network cost model into the epc to be used when modelling the network.

Whilst the theoretical maximum is 99%, the achievable epc is determined by a number of factors including the network design. As the number of nodes in the mesh increases, the average size of route decreases and the overall network design becomes less efficient. For example, the theoretical maximum for a 65 node fully meshed DMSU network is 0.804 epc. The network has to be able to cope with peaks and not just the busy hour traffic. Utilisation and out of service plant (upgrades, rearrangements, faulty, replacement) also need to be factored in.

Table 5: Traffic model of BT UK DMSU Network[46]

Traffic model (Modularity applied for each output)	Erlangs per circuit
Theoretical maximum	0.804 epc
90% utilisation	0.722 epc
Measured growth of 20% per year, 6 month re-order period	0.656 epc
Peak to average @ 8%[47]	0.608 epc
OOS DTLs @ 5%	0.576 epc

Source: BT

It is important to recognise that epc is only one measure of network efficiency. Overall optimisation of switch and transmission costs is the primary aim and the absence of some of the transmission costs from the proposed NGN model implies that overall optimisation cannot be achieved through this approach.

5.2 Network management

The TDM networks have a number of control measures to safeguard against network over-load e.g. temporary alternative routings, destination call gapping and route call gapping. These control measures are required to allow the proposed network to cope with network failure, disasters, media events, peak days and events, e.g. 30m premium rate calls in 20 minutes as a result of telemarketing and TV shows.

These network control measures are required because the network design assumptions used in traditional network modelling (where traffic offered is random, peak loads do not occur

[46] Based on mean busy hour measured traffic for 3 week sample.

[47] Oftel TG13 Study Group.

simultaneously and overflow traffic follows erlang's B formula) are no longer valid in today's networks.

It is not clear how these safeguards are to be provided in the proposed NGN model or where these costs would fall.

5.3 Copper versus fibre broadband

Section 2.2 of the proposed NGN documentation notes that "Access lines are assumed to be copper based". Further, section 3.12 states that "*At the BA node, customers' copper access lines are terminated for PSTN, ISDN and broadband access. The copper lines terminate on Multi-Service Access Nodes. The BA node has limited switching functionality to provide network resilience and node redundancy in the event of optical equipment or MSAN failure.*" And "*Multi-Service Access Node: The MSAN terminates copper lines for PSTN, ISDN and broadband services. It acts as a gateway, adapting the data and signalling for these services into IP packets for the NGN (and vice versa). The MSAN has a Gigabit ethernet interface for IP traffic.*"

The BA node/MSAN coincides with BT's Concentrator/MDF sites. With the roll-out of Fibre to the Cabinet (FTTC) the copper lines for voice will terminate at the BA node, but the broadband is provided over a fibre link between the cabinet and the BA node. So, in reality, either the FTTC cabinet grooms the data traffic off the copper network and delivers it as GiG-E traffic to the NGA Handover node or the MSAN is actually located in the FTTC cabinet rather than the BA node.

With exchange based DSL technology (ADSL, ADSL+) the copper pair is shared between the data and the voice services. With FTTC the copper pair between the cabinet and the exchange is dedicated to the voice service and the fibre is dedicated to the data service. As such, the proposed NGN model documentation is incorrect when it states that "*At the BA node customers' copper access lines are terminated for …….. broadband access*" as increasingly broadband access is terminated at the cabinet and the traffic groomed off into the IP network.

BT's business broadband service provides direct fibre access for broadband to the business premise. For these customers the copper network is used exclusively for voice. The roll-out of fibre (FTTC or FTTP) will reduce the data traffic carried on the copper network, increasing the amount of copper used exclusively for voice.

The data traffic from a FTTC cabinet would be delivered to a CP at the NGA handover node. The entire cost of the MSAN and associated transmission equipment and plant in this scenario would be attributable to BT voice as it would only be used for voice traffic.

The model assumes that voice and broadband traffic are separated in the AN by an ethernet switching layer. Voice traffic is assumed to be switched directly to MPLS edge routers, whilst broadband traffic is assumed to be directed via Broadband Remote Access Servers. However, with the introduction of FTTC and FTTP the voice and broadband are separated before they reach the AN. Indeed, they are separated before they reach the BA node and can be delivered to the AN on physically separate dedicated media. Effectively, the MSAN (of the proposed NGN model) has been moved to the cabinet or the customer's premise respectively and accordingly there will be many more of them.

5.4 Extrapolation of a CP NGN to model BT's NGN

Throughout the proposed NGN model documentation and the consultation, Ofcom refers to the use of network information from other CPs, who have already rolled out NGN, being a suitable proxy for BT's costs. However, there are a number of reasons why this approach may lead to erroneous results.

Firstly, compared to other CPs, BT has to consider factors such as jitter, delay and echo cancellation to a greater extent. Also, BT has to carry a number of additional services: any service that other CPs cannot carry successfully is brought wholesale from BT. Examples are medical alarms, some faxes and some modems. Consequently, BT needs to incur higher costs compared to other CPs in order to configure its network to account for these factors.

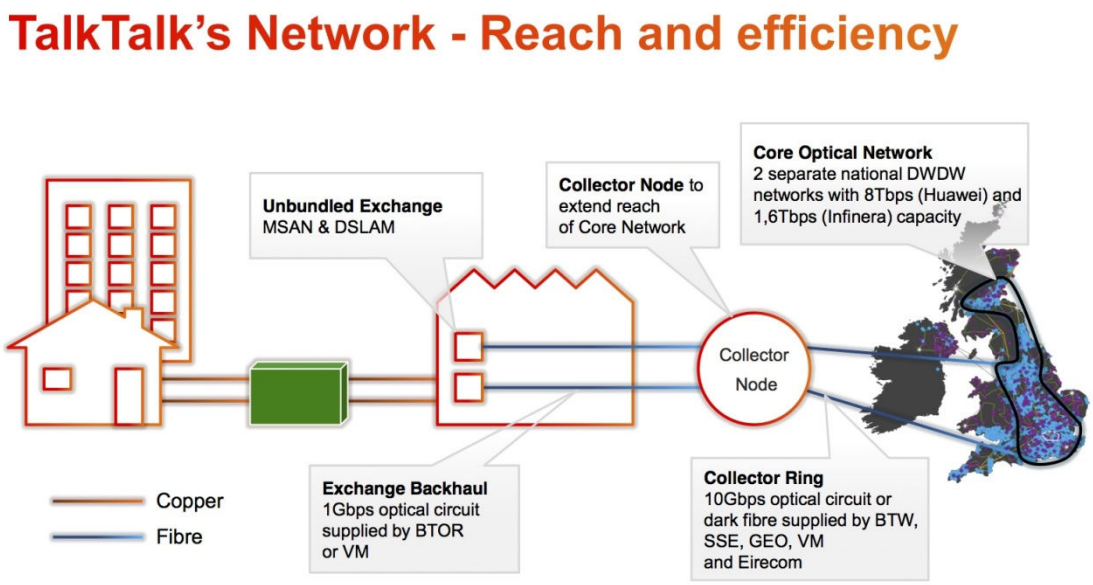
In addition, the network coverage of the other CPs is sub-national and these CPs are unlikely to incur the same costs as BT's for serving customers in more rural or expensive areas. In its narrowband market review (page 160), Ofcom notes that "*Whilst the geographic coverage and the scope of services provided by NGNs currently deployed in the UK may not be as comprehensive as that provided by BT, these networks connect to substantial numbers of consumers across a significant proportion of the UK*."

Ofcom also references TalkTalk's NGN in its consultation paper. However, TalkTalk's NGN network is optimised for TV and is therefore not a suitable comparator.[48] This is explored further below.

- The easiest way to optimise a CP's IP network for TV is to off-load the voice traffic by using separate MPLS edge routers for voice and broadband and then to off-load the peaks of the voice traffic to BT's transit network.

[48] http://www.talktalkgroup.com/~/media/Files/T/TalkTalk/pdfs/presentations/2012/strategy-update-pres.pdf%20title= page 32

Figure 45: TalkTalk's network



Source: TalkTalk

- If a CP were to provide an NGN network configured to carry voice, the CP will assume that peak traffic can be off-loaded onto BT's network. This allows the CP to run their NGN at a higher utilisation for a given service level than BT is able to do. The higher utilisation is reflected in lower costs. The CP is not required to meet the same high levels of resilience and assurance as BT. If a link goes down in the CP's network the traffic can be re-routed over BT's network and BT has to design this requirement into its network as there is no reciprocal requirement on the CP to take BT's traffic in the event of a link failure. Some allowance therefore should be made when modelling BT's NGN on a CP's NGN to allow for BT's inability to run its NGN at the high(er) utilisation achievable by the CP.

- A CP's network is not required to carry all of the services that BT has to carry. Services which have exacting requirements for jitter, delay etc can be bought wholesale from BT where this is more economic for the CP than providing the service on their network. The specification of BT's network is therefore more challenging than that for a CP's network and in meeting these challenges the cost is inevitably higher.

Echo cancellation

There is no echo cancellation in the BT TDM network. There is echo cancellation at the international gateways and in the mobile networks.

"Echo cancellation should be employed in any network that uses packet- or cell-based technologies as the delay introduced by such technologies is likely to push the end-to-end delay above 25ms.

Echo cancellers compliant with the requirements of ITU-T Recommendation G.168 should be employed.

The presence of an echo canceller in a call path should be signalled to adjacent networks in accordance with ITU-T Recommendation Q.115. Ideally all echo cancellers should be disabled with the exception of the two closest to the two potential sources of echo." [49]

The assumptions made regarding the provision of echo cancellation should be made explicit by Ofcom.

[49] UK National Transmission Plan Issue 5, March 2006 p24.

Glossary

Acronym	Definition
AAGR	Average Annual Growth Rate
AAR	Automatic Alternative Routing
ADSL	Asymmetric Digital Subscriber Line
AN	Aggregation Node
BA	Basic Access (node)
BRAS	Broadband Remote Access Server
BT	British Telecom
CAGR	Cumulative Annual Growth Rate
CCITT	Comité Consultatif International Téléphonique et Télégraphique
CMSG	Cambridge Strategic Management Group
CN	Core Node
CP	Communications Provider
DLE	Digital Line Equipment
DMSU	Digital Main Switching Unit
EE	Everything Everywhere
epc	Erlangs per Circuit
FTTC	Fibre to the Cabinet
FTTP	Fibre to the Premises
FTTH	Fibre to the Home
GoS	Grade of Service
HD	High Definition
IP	Internet Protocol
ISDN	Integrated Services Digital Network
LRIC	Long Run Incremental Cost
LTE	Long Term Evolution
MSAN	Multi-Service Access Node
MPLS	Multi Protocol Line Switching
NCC	Network Charge Control

NGA	New Generation Access
NGN	New Generation Network
Ofcom	The Office of Communications
PBX	Private Branch Exchange
PSTN	Public Switched Telephone Network
VDSL	Very-high-bit-rate Digital Subscriber Line
SA	Super Access (node)
SMP	Significant Market Power
TDM	Time Division Multiplexing
WLL	Wireless Local Loop
4G	4 Generation