WIK-Consult • Report

Study for TalkTalk

Estimating the cost of GEA

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1 Executive Summary

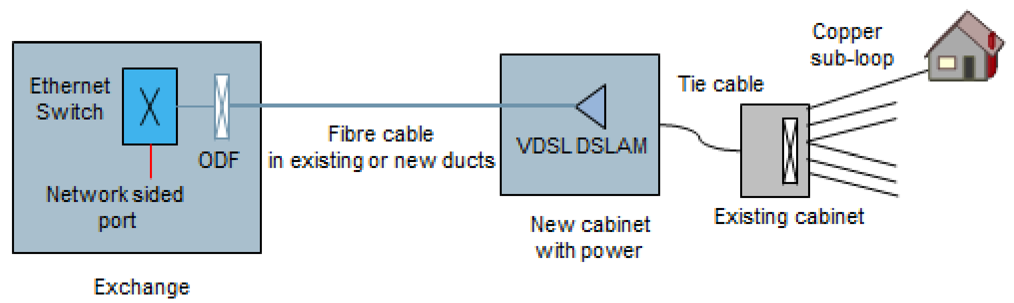
In the context of the ongoing review of the wholesale local access (WLA) market in the UK, TalkTalk commissioned WIK-Consult to estimate the costs incurred by British Telecom (BT) in providing Generic Ethernet Access (GEA) and compare it with the prices charged by BT Openreach.

In this report, which is accompanied by two models developed by WIK, we describe the method used for the cost estimation and penetration forecast, central assumptions and the results of sensitivity tests. We conclude by reporting on benchmark charges for FTTx-based wholesale products in other markets, with particular attention to cases where these have been calculated by national regulatory authorities on the basis of cost-orientation.

Modelling approach

The model estimates the cost of GEA (a schematic diagram of which is shown in Figure 1-1). The GEA product consists of the additional fibre network elements and equipment installed by BT Openreach (BTOR) between the local exchange and street cabinet in order to offer superfast broadband (SFBB) on the basis of fibre-to-the-cabinet (FTTC)/VDSL infrastructure. It should be noted that, in addition to GEA, either copper LLU or WLR must also be purchased by operators in order to offer superfast broadband (SFBB) services to customers.

Figure 1-1: Generic Ethernet Access, schematic description



Source: WIK

Bottom-up cost models such as those prepared for national regulatory authorities to determine regulated charges normally aim to model in detail the precise network architecture and associated costs of an efficient operator. In this exercise, we followed a simplified approach which is based on modelling the costs of a representative Main Distribution Frame (MDF), ie an MDF with an "average" number of lines and street cabinets applicable to BT's roll-out area of FTTx, which in this case was the commercial FTTx roll-out target of 19m homes announced by BT for completion by Spring 2014[1]. Whilst the models could also be adapted to estimate the costs of an extended FTTx roll-out to 90% households using subsidies from Broadband Delivery UK (BDUK), we did not do so on this occasion due to some uncertainties about the timing of this roll-out and the level of associated subsidies.

Information concerning the architecture of BT's access network including geographic variations was taken from a report by Analysys Mason for the BSG[2]. The table below shows how this information was used to match BT's roll-out plans. The goal of this exercise is to derive the average parameters in the shaded cells as inputs for the cost model. The parameters for the average MDF were based on the characteristics of exchanges covering 88% of UK premises. This is a conservative estimate that assumes that BT's coverage area would be wider than only the most densely populated regions, which could be presumed to have the lowest costs.

Table 1-1: Rough match of BT roll-out information to Analysys/BSG geotype data

Data base	Premises	% of total premises	exchanges	cabinets	avg. premises per exchange	avg. cabinets per exchange	avg. premises per cabinet	avg. feeder length / cabinet (m)*
Target from BT press release	ca. 19,000,000	*70%* *(19mn / 27mn)*	ca. 1,700	"10s of 1000s"	*11,176* *(19mn/1,700)*			
Base over first 9 exchange types (chosen database)	23,862,750	88%	2,046	74,684	11,663	37	320	1,154
National average	27,256,460	100%	5,578	90,001	4,886	16	303	1,144

* derived as total feeder length divided by number of cabinets (Fig. A.2 in Analysys Mason (2008)) [3]
Source: BT press release, Analysys Mason for BSG

Treatment of costs

In preparing our estimate, where possible we used cost parameters from models prepared or commissioned for Ofcom such as the Narrowband Charge Control model . These have been complemented by international comparisons (e.g. regulatory decisions, studies or cost models) and WIK's own benchmarking database. Regarding the cost of (co-)location at the exchange these have been based on Openreach's "Co - Mingling Medium Capacity Unit MCU-1" as proxy for all colocation related costs at the

1 BT press release DC13-027, February 12th 2013. http://www.btplc.com/News/Articles/Showarticle.cfm?ArticleID=23F28D29-F8B5-4EC0-A3F8-04C1FEA340F1
2 "The costs of deploying fibre-based next-generation broadband infrastructure"; http://www.broadbanduk.org/2008/09/05/bsg-publishes-costs-of-deploying-fibre-based-superfast-broadband/
3 The observation that average feeder length over the first 9 exchange types is higher than the nationwide average over all geotypes is explained in section 3.1.

exchange (including power, uninterrupted power supply, space, tie cables etc.). Common costs are reflected through a 10% mark-up on total cost.

Key assumptions

The results of cost models are critically dependent on a number of assumptions, prime amongst which are assumptions concerning penetration (take-up of GEA on the FTTC platform), the weighted average cost of capital (WACC) including any risk premium applied to NGA, and the extent to which existing ducts can be reused for the installation of fibre between the street cabinet and local exchange. The depreciation method and asset lifetimes are also significant.

Forecasting penetration

In order to make predictions about SFBB penetration over the coming years, we developed a model of the evolution of the broadband market as a whole, drawing on actual data from 2010-2012 and making projections on the basis of historic trends in the UK and European benchmarks. The model assumes slight growth of 0.8% per year until 2020 in households and 0.8 percentage points increase in broadband penetration. It also assumes that the current (Dec-12) retail broadband market shares (divided between Virgin Media, BT Retail and other operators on the BT Openreach platform) will remain stable over time on the basis that regulatory and market conditions will ensure that the retail broadband market, including SFBB, will remain competitive.

A key assumption which drives the predicted take-up of SFBB overall is the proportion of broadband customers on each operator's network which are projected to subscribe to SFBB and the growth rate in take-up.

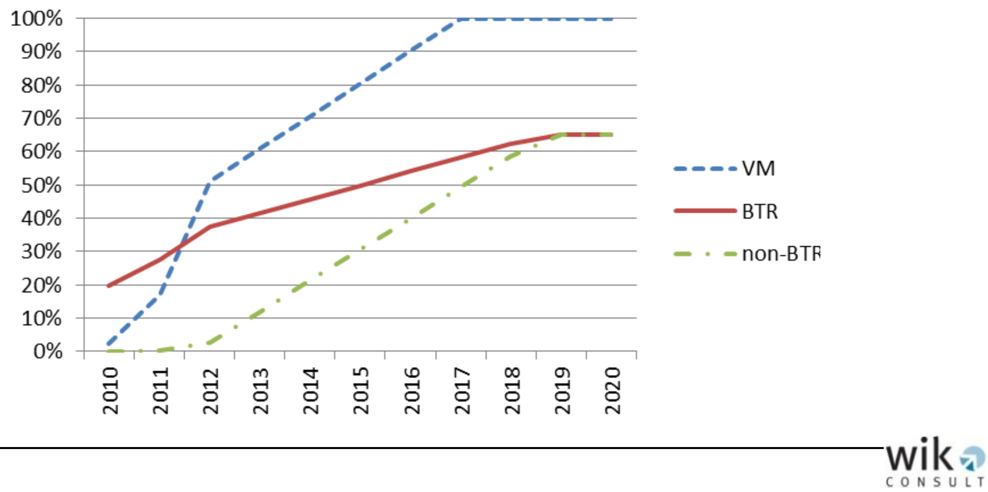
The base case penetration is based on the assumption that in the coming years, 100% of Virgin Media customers and 65% of broadband customers on the BTOR FTTC platform would migrate to SFBB. The 65% figure can be considered a conservative assumption on the basis that take-up by BT Retail customers within served areas is more than 30% and BT reports that more than half of new retail customers are subscribing to fibre products[4]. Since some exchanges have only been upgraded to FTTC recently, a further increase in take-up at these exchanges could be expected as they 'mature'. Analyst reports suggest that in areas where FTTC has been available for longer uptake rates for BT Retail are about 50%[5]. Sensitivities have also been conducted for 80% take-up and 50% take-up of SFBB as a proportion of broadband customers on the BT Openreach platform. The chart below shows the projected take-up rate of SFBB as %

4 http://www.btplc.com/News/ResultsPDF/q212_release.pdf

5 Enders:. *High speed broadband take-up accelerated during the [last] quarter [of 2012]... High speed adoption is now 16% of the BT broadband base, but we estimate adoption at over 30% of BT broadband homes passed by the fibre roll-out (and over 50% in some areas that were passed early on). The adoption rate is thus accelerating even though penetration is quite high already, suggesting that it is receiving good word-of-mouth and that it is far from niche interest, with eventual adoption likely to be well over 50%.*

broadband customers by Virgin Media (VM), BT Retail (BTR) and other operators over time for the base case.

Figure 1-2: Take-up of Super Fast Broadband by operator (year end figures)

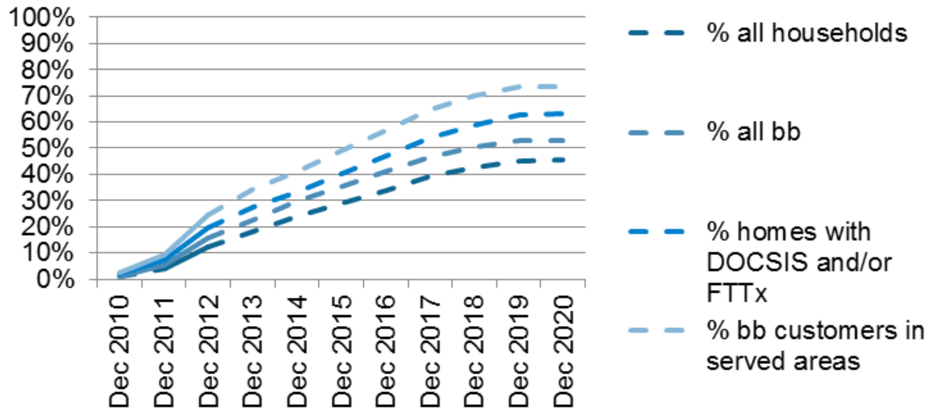


Source: Operator data, WIK forecast, Data to Dec-12 is actual

These projections concerning take-up of SFBB would result in around 40% of customers with NGA-enabled homes taking SFBB by end 2014 and 60% by end 2020. This is compatible with European benchmarks in countries which have had NGA infrastructure in place for some years and therefore could be seen as forerunners to likely developments in the UK. For example, as a proportion of NGA homes passed, Sweden and Belgium had achieved 38% and 43% take-up of NGA-based broadband respectively at the end of 2011[6].

6 Source: IDATE/FTTH Council, Point Topic for EC

Figure 1-3: Percentage of customers taking Super Fast Broadband

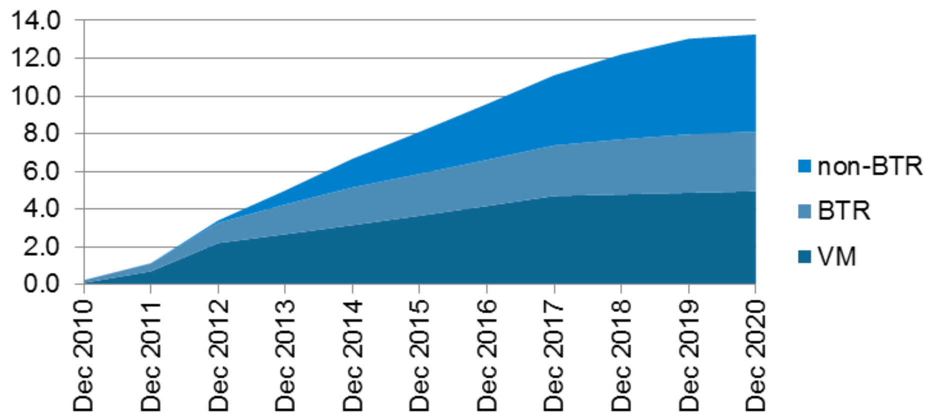


Source: Operator data, WIK forecast

As shown in Figure 1-4, total retail SFBB lines would increase to around 13m by 2020. This would further rise to 16m if coverage of FTTx reached 90% with the additional support of Broadband Delivery UK (BDUK) funding.

The evolution in market shares projected by the model implicitly assumes that whole-sale conditions for GEA enable a catch-up by competitors on the BTOR platform such that by 2020 the resulting market shares in SFBB are comparable with those for stand-ard broadband today. If 90% coverage is modelled, BTR and other operators on the BTOR platform would gain a larger share of the overall market as FTTC was rolled out further beyond cable areas.

Figure 1-4: Super Fast Broadband lines by operator

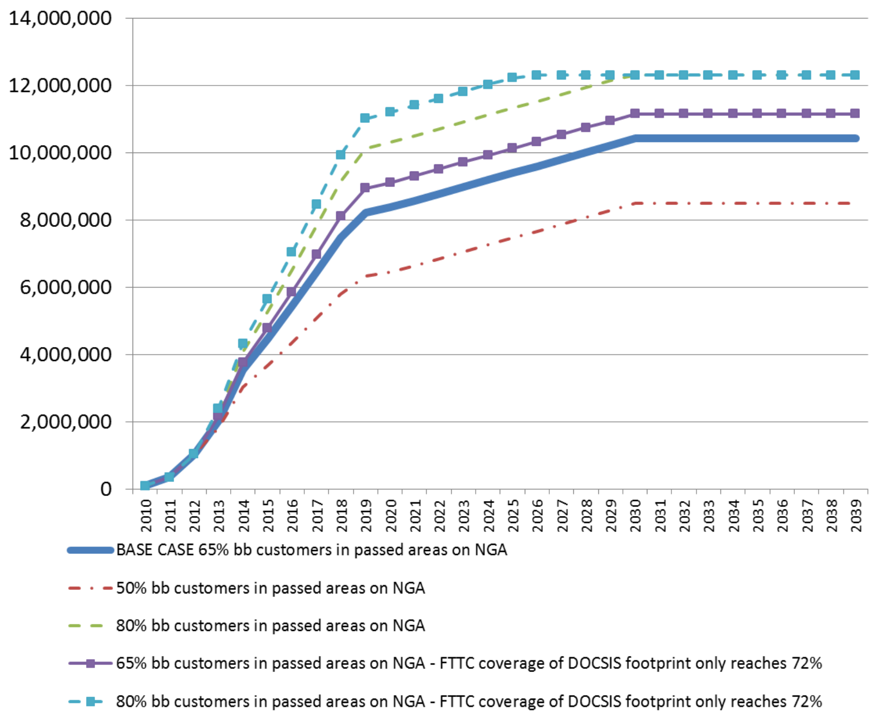


Source: Operator data, WIK forecast

The main output from the penetration model which is used in estimating GEA costs is the number of subscribers in FTTx enabled areas connected via GEA. These figures are shown in Figure 1-5. Whilst we do not explicitly forecast the numbers, we assume a further gradual increase in GEA take-up of 1% per year between 2020 and 2030, after which we assume no further growth.

One factor which affects GEA take-up is the extent to which BT's commercial roll-out of FTTC overlaps cable areas. In this context, it is notable from available data for 2011[7] that BT 48% of BT's FTTx coverage in 2011 was outside Docsis areas. A higher proportion of roll-out outside Docsis areas would have the effect of increasing take-up of GEA because BTOR does not face competition from cable in such areas and thus its market share approaches 100%. In the base case, we took a conservative assumption that BTOR would change its focus to cover cable areas in order to preserve its existing market share in these areas and that FTTx would cover 95% of cabled areas by the end of 2013. We also modelled an alternative scenario (shown in Figure 1-5) in which BT continues its current deployment pattern resulting in a lower FTTC overlap of Docsis of 72%. This would have the effect of increasing take-up of GEA overall.

Figure 1-5: Number of subscribers under different penetration profiles (year-end figures)



Source: WIK cost model

7 Point Topic 2012 for European Commission https://ec.europa.eu/digital-agenda/en/news/study-broadband-coverage-2011-updated

WACC assumptions

Concerning WACC, our base case uses the current nominal WACC used for LLU (8.8%) by Ofcom[8] to which is added a risk premium of 2% for fibre cables and equipment associated with the provision of GEA.

Only limited benchmark data is available for this parameter and views diverge on whether FTTC as distinct from FTTP should be eligible for a risk premium. In a report for German telecoms regulator Bundesnetzagentur in 2010[9] a difference between the copper and fibre WACC of 2.59% is suggested, but this applies only to FTTP. The report suggests that FTTC should not be eligible for such a premium because the risk of FTTC/VDSL is deemed significantly lower than the risk of FTTP. The report argues that the risk profile of FTTC/VDSL corresponds to that of xDSL or cable.[10] Belgian NRA BIPT concluded in 2011 that no risk premium should be applied to the VDSL bitstream provided by Belgacom on the basis that coverage reached 80% of households and returns were being made on the investment[11]. Spanish regulator CMT has proposed a risk premium of 4.81% for bitstream provided on the basis of fibre[12], but it is not clear whether this is applicable to FTTC.

Arguably, the current take-up rates of SFBB by VM and BTR's customer-base imply that the demand-risk for SFBB is at the lower end of the scale in the UK. Reported Capex by BTOR[13] has also been relatively stable in recent years suggesting that FTTx investment may to some extent have replaced or complemented previous investments in copper infrastructure. This would be supportive of a lower risk premium. For completeness, we model sensitivities based on risk premia of 4% and 0%.

No risk premium is assumed for ducts in the base case on the basis that they may be used for purposes besides GEA and it is not clear the extent to which depreciated ducts may have been replaced or refurbished in the absence of an FTTC programme. However, we include a sensitivity in which newly built ducts for GEA are also subject to the same risk premium as fibre cables and equipment[14].

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8 See p. 129 in Ofcom's 2012 Charge control review for LLU and WLR services – Annexes.

9 See p.26. in Stehle (2010): "Wissenschaftliches Gutachten zur Ermittlung des kalkulatorischen Zinssatzes, der den spezifischen Risiken des Breitbandausbaus Rechnung trägt" http://www.bundesnetzagentur.de/cae/servlet/contentblob/194320/publicationFile/9936/Gutachten

10 See p. 14 / 15 in Stehle (2010)

11 https://circabc.europa.eu/sd/d/6258f6e4-8626-4db3-8f0d-25953874f691/M4-5-decision-publication-FR.pdf

12 http://blogcmt.com/2013/03/06/la-cmt-aprueba-la-prima-de-riesgo-para-la-fibra-optica/#more-32279

13 BT quarterly results http://www.btplc.com/Sharesandperformance/Quarterlyresults/Quarterlyresults.htm

14 If some ducts may have been refurbished irrespective of an FTTC programme and may be used for other purposes a risk uplift of 2% might be considered excessive. An alternative approach towards the WACC and the treatment of ducts could be to include ducts but set the premium to 1%. Under this approach, the outcome is not significantly different from the base case.

Duct re-use

Concerning duct re-use, the base case assumes that 70% of ducts can be reused for the roll-out of FTTC. This is based on information from two studies by Analysys Mason that address degree of duct reuse. In the study 2008 for the BSG ("The costs of deploying fibre-based next-generation broadband infrastructure") a duct reuse of 80% is assumed. In its 2009 study "Telecoms infrastructure access – sample survey of duct access" for Ofcom, the analysis shows that 78% of duct-ends have space for a new 25mm subduct. This gives some indication of re-use potential although it does not necessarily mean that the full length is usable for example because of congestion in duct nests or collapsed sections of ducts that cannot be determined from analysing duct-ends alone.[15] Therefore we have decided to use a base case with 70% duct-reuse. We have also conducted sensitivities with 80% and 50% duct re-use.

Depreciation and asset lifetimes

The model considers a timeframe of 60 years. Upon reaching the end of an asset's lifetime it is replaced causing new investment. Investments (and OPEX) are recovered over the full timeframe of 60 years, not over their individual lifetimes. The stream of investments was discounted to present value with the nominal WACC. No terminal value was considered with a timeframe of 60 years being considered sufficiently long that cost at the end of the consideration period becomes practically immaterial through discounting.

Generally, the present value of all amortisation payments must equal the present value of the investment stream over the consideration period of 60 years. Cost recovery is modelled on the assumption that depreciation needs to be in proportion of customers and that it needs to reflect the average unit cost profile. Accordingly, amortisation payments for CAPEX and OPEX were derived through economic depreciation, under which amortisation is scaled according to the network's output, the subscribers, accounting for changes in asset prices. This made sure that if an asset is expected to have a higher nominal cost in the future the cost per unit (per line) in future periods reflects this (since cost-based prices serve as make-or-buy signals for potential market entrants).

Lifetimes of 40 years for ducts, 20 years for fibre cables and cabinets, and 8 years for active electronics were used to determine renewal investments.

Results

The base case assumptions can be summarised as follows.

15 In their 2009 study "Telecoms infrastructure access – sample survey of duct access" Analysys Mason notes the following reasons why unoccupied duct-end space does not directly translate into useable duct space: Duct nets may be too congested to have access to an empty duct at the bottom. Ducts might have collapsed in the middle of a section. Cable arrangements in the duct may be such that existing cable cross-over may prevent further cables being inserted.

Table 1-2: Summary of base case assumptions

Item	Assumption
WACC	8.8%
WACC for fibre cables, active electronics, new cabinets	2%
DSLAM	£3,000 plug-in unit, £16.67 per port, lifetime 8 years.
New cabinet including power, tie cable etc.	£5,200, lifetime 20 years
Premises per cabinet	341 (accounts for household growth)
48-fibre cable (material and installation)	£2.75 per meter, lifetime 20 years
Installation cost per duct metre	£57.52, duct lifetime 40 years
Average length of feeder segment between MDF and cabinet	1,154m
Duct reuse	70%
Annual OPEX as % of investment (excluding power)	Active electronics 8%, passive infrastrucure 0.5% / 1%
Indirect Investment % of direct investment	In total 5.5% for motor vehicles, workshop facilities, office equipment, land and buildings, general IT and other network support equipment
Common cost % of total cost (Common cost is cost on the level of administration and management that cannot be allocated to individual services.)	10%

Applying the base case assumptions leads to a **monthly cost per line of £4.39 in 2013**.

Table 1-3: Monthly cost per line in the base case

Monthly cost per line (nominal £)	**4.39**
CAPEX per line	3.11
OPEX per line	0.88
Common Cost	0.40

Checking the results against BT's announcements

In order to compare the investment predictions in the model with the £2.5bn announced by BT a simple sum of the initial investment for setting up the network (without considering renewals) was derived.[16] The model shows a real value for initial investments without renewals of £2.25bn which is comparable to BT's estimate of costs. Dividing the

16 This just counts the necessary investment for all cabinets, ducts, DSLAMs (including all line cards which depend on the subscriber evolution) and so on but does not account for renewals. This value signals the investment to build the network once in 2010 in order to compare it to BT's announcement.

initial investment (including DSLAM line cards[17] for the estimated subscriber base) by the number of passed homes yields a (real terms) investment per home passed of £110.[18] This investment reflects deployment of FTTC at 1650 MDFs, compared with BT's announced roll-out to 1,700 MDFs. The length of deployed cables is roughly 69,000km which compares with "more than" 50,000km estimated by BT. The number of passed homes is 20.5m (inflated through household growth from an initial coverage base of 19mn) and the number of subscribers converges towards 10.4mn (ca. 51% penetration within homes passed).

It should be noted that the total investment of £2.5bn reported by BT for FTTx would imply that a significant proportion of total BTOR investment is associated with FTTx, meaning that there should be a corresponding reduction in capex for legacy platforms. It is possible therefore that the total reported investment for FTTx is an overestimate, which may include investment that is not specific to FTTx and may have occurred otherwise.

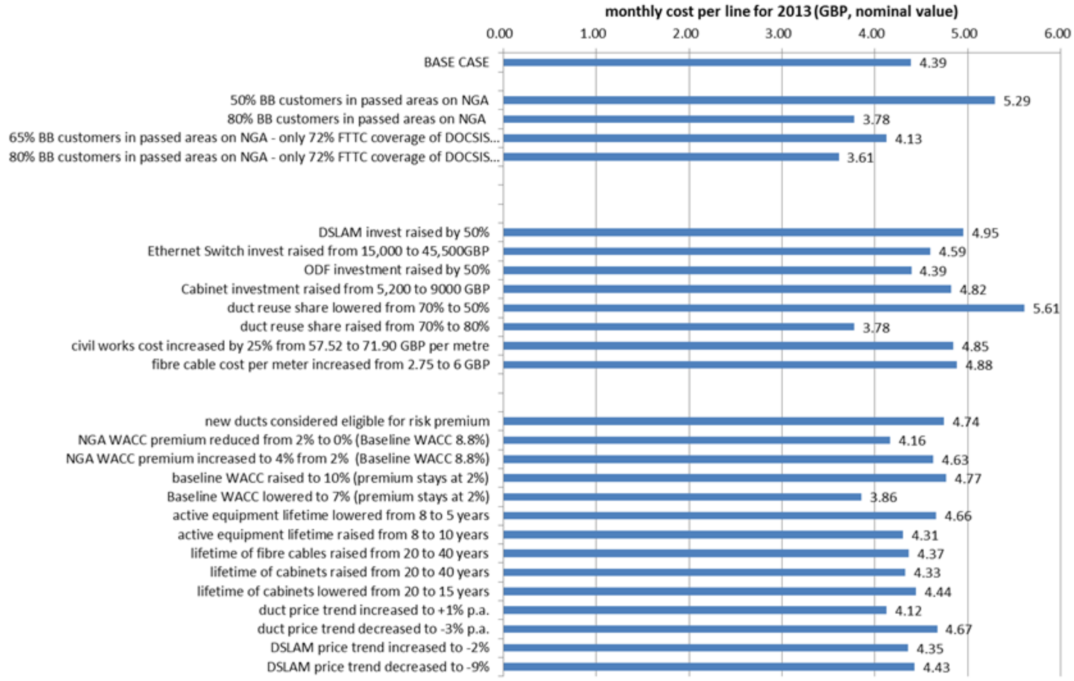
Sensitivities

As described above, a large number of sensitivities were calculated around the base case. A summary of the results of these is shown below. On the basis of these sensitivities, we would conclude that a cost-reflective charge for GEA should lie between £4.00 and £5.50, depending on the assumptions used. The model shows the greatest sensitivity to duct re-use. However, reducing assumptions concerning re-use from the base case level of 70% to 50% would also lead to predictions concerning total investment that would be considerably higher than the £2.5bn reported by BT. This provides some confidence that the assumptions on the rate of duct re-use are appropriate.

17 The customer ports on the DSLAM to which the copper sub-loop is connected. These are only installed for subscribers.

18 In a greenfield sensitivity where duct reuse was set to 0% the investment per passed home increased to £275.

Figure 1-6: Summary of stand-alone sensitivities conducted



Comparing estimated costs with BTOR GEA charges

In constructing the cost model we found that there are practically no bandwidth driven cost components so a uniform price per GEA line was reported. This is due to the fact that the bandwidth between end customer and DSLAM is unshared and even the DSLAM with its fibre backhaul link does not limit bandwidth. A similar approach was used by BIPT in setting cost-oriented charges for VDSL bitstream with local exchange handover in Belgium. Charges approved by German regulator BNetzA for VDSL bitstream with regional handover are also not differentiated between access line speeds. In contrast, Openreach GEA pricing is differentiated according to downstream / upstream bandwidth combinations. The table below shows monthly pricing for products below 100Mbps downstream, i.e. in the relevant bandwidth range for FTTC. The prices range from £7.40 to £9.95 per month.[19]

19 At the time of writing Openreach was also offering a 40Mbps downstream / 2 Mbps upstream product for £6.90 which was about to be withdrawn.

Table 1-4 Openreach GEA pricing below 100Mbps valid from April 1st 2013

Product combinations (downstream / upstream)	Annual charge	Monthly charge
40 Mbps / 10 Mbps	£88.80	£7.40
40 Mbps / 15-20 Mbps 80 Mbps / 20 Mbps	£119.40	£9.95

Source: Openreach website

These charges are higher than the cost model base case cost of £4.39 and exceed the sensitivities described in Figure 1-6.

2 Introduction

WIK was asked by TalkTalk to estimate – through a bottom-up cost calculation - the cost to BT Openreach of providing Generic Ethernet Access (GEA) over Fibre-to-the-Cabinet (FTTC) in order to compare it with the price charged by BT Openreach. The cost analysis is complemented with a benchmark analysis of the charges for European fibre wholesale products, where these were calculated on the basis of cost-orientation.

Section 3 contains the description of the modelling approach including all assumptions and parameter selections.

Section 4 describes assumptions on the penetration forecast.

Section 5 summarizes results of the cost model and compares them with the current GEA prices.

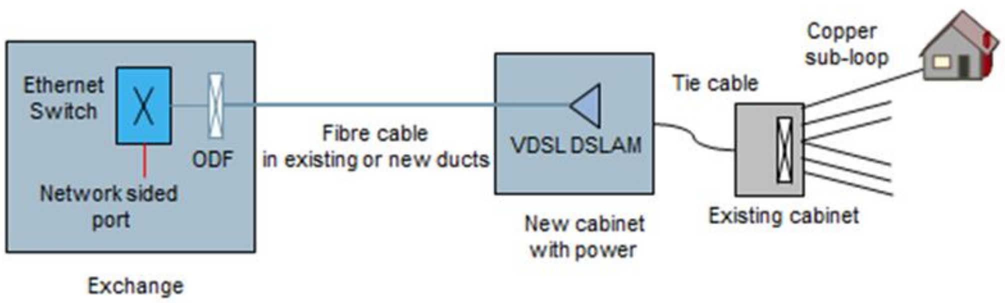
Section 6 closes with a benchmarking analysis of international wholesale products.

3 Modelling approach

This section explains the modelling approach towards building a bottom-up cost cost model to determine BTOR's cost of providing GEA over FTTC. The calculation reflects the cost of rolling out FTTC and providing GEA over it in the footprint of BT's targeted commercial FTTC rollout area. According to BT this covers roughly 19m premises (~70% of British premises).[20] The model could be adapted to estimate the cost to cover 90% of premises with the aid of funding from BDUK. However, it was decided to limit the assessment to the commercial roll-out due to uncertainties around the timing and subsidies available for the additional investment.

It should be noted that the cost for GEA estimated by the model is a separate and additional cost to the cost of the unbundled local loop, i.e. there are no copper loop costs considered within this cost model. Figure 3-1 shows the underlying network structure.

Figure 3-1: Schematic overview of the considered network structure



Accordingly, the network elements taken into account in the cost model are:

- DSLAMs (including their energy costs), patch cables and splitters at the cabinets,
- New cabinet including tie cables and power connection
- Duct space and fibre cable between cabinet and exchange (the "feeder section")[21]
    - Ducts can be existing ducts or new-built/refurbished ducts

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20 BT press release 12.02.2013. http://www.btplc.com/News/Articles/Showarticle.cfm?ArticleID=23F28D29-F8B5-4EC0-A3F8-04C1FEA340F1

21 "exchange" is here used synonymously with "MDF location".

  - For existing ducts only the cost of installing fibre is considered since the duct cost is fully accounted for in other wholesale products.

- Optical Distribution Frames (ODFs) at the exchanges
- Ethernet Switches at the exchanges including the network sided ports for the access seeker (the alternative operator buying GEA)
- "Colocation" related cost such as space, energy, cooling, handover, access, and tie cable. These are modelled through the "Co - Mingling Medium Capacity Unit MCU-1" wholesale product.

The following sections explain how network data was obtained and discuss the assumptions regarding investments, cost and other parameters as well as the methodology for depreciation and forecasting penetration.

3.1 Data source for approximating the network structure of BT's commercial FTTC roll-out

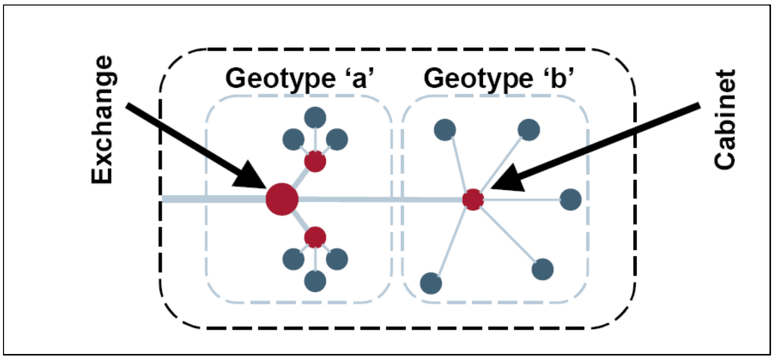
When calculating costs using a bottom-up model, the most detailed and precise - but also the most time-consuming - approach is to use actual MDF and street cabinet (geo-) data in order to model the GEA cost for each FTTC street cabinet. An average value is then derived from this. This very detailed approach, which has been used by WIK to undertake bottom-up cost calculations for various national regulatory authorities, was beyond the scope of this project. Instead, a more pragmatic solution was chosen which relies on existing public domain information on BT's access network structure.

The simplified approach to cost estimation used for this study relies on a representative MDF that reflects the characteristics of the average MDF given BT’s roll-out. The deployment in the model is then scaled by increasing the number of MDFs deployed until the targeted number of passed premises is reached (in this case ca. 19mn premises). The representative MDF is defined by the

- number of premises per MDF,
- number of cabinets per MDF,
- number of premises per cabinet,
- length between MDF and cabinet,
- deployment cost per metre for new ducts (see section 3.3),
- degree of duct-reuse in the feeder segment (see section 3.3).

The Broadband Stakeholder Group (BSG) commissioned a study on "The costs of deploying fibre-based next-generation broadband infrastructure" in 2008.[22] This report, written by Analysys Mason, contains data on BT's network differentiated by 13 geotypes. The network information from that report has been used for defining the average MDF in this study. The BSG study subdivides geotypes 4 to 13 into a denser central core ('a' geotype) of the exchange and a wider area of sparse settlements ('b' geotype) connected to the same exchange.[23]

Figure 3-2: Different geotypes within an exchange area in the Analysys Mason report for BSG



Source: Analysys Mason (2008)

Table 3-1 provides an overview of some of the available geotype information compiled from the BSG report. The task was to determine the average MDF inputs shown above by selecting a plausible subset of all geotypes that roughly matches the actual BT rollout areas.

22 "The costs of deploying fibre-based next-generation broadband infrastructure"; http://www.broadbanduk.org/2008/09/05/bsg-publishes-costs-of-deploying-fibre-based-superfast-broadband/

23 See Analysys Mason (2008): p.35f. "Exchanges tend to cover the central core of a settlement, and wider areas of sparse settlements. To reflect this, we have defined a sub-division into 'a' and 'b' geotypes (based on distance from exchange) in those geotypes that are primarily based on the number of lines per exchange."

Table 3-1: Overview of geotypes in the BSG 2008 report

Geotype ID	Geotype name	Total number of premises (incl. business)	% of premises	cumulated premises	**cumulated % of premises**	exchanges	lines per exchange	Premises density (per sq. Km)	exchanges cumulative	lines per exchange cumulative
1	inner london	1,445,789	5%	1,445,789	**5%**	86	16,812	3,641	86	16,812
2	>500k pop	3,164,456	12%	4,610,245	**17%**	204	15,512	1,282	290	15,897
3	>200k pop	2,794,786	10%	7,405,031	**27%**	180	15,527	1,016	470	15,755
4	>20k lines (a)	2,853,914	10%	10,258,945	**38%**	167	17,089	1,360	637	16,105
5	>20k lines (b)	1,744,926	6%	12,003,871	**44%**		10,449	453	637	18,844
6	>10k lines (a)	4,355,457	16%	16,359,328	**60%**	406	10,728	854	1,043	15,685
7	>10k lines (b)	1,553,331	6%	17,912,659	**66%**		3,826	190	1,043	17,174
8	>3k lines (a)	2,759,317	10%	20,671,976	**76%**	1003	2,751	876	2,046	10,104
9	>3k lines (b)	3,190,774	12%	23,862,750	**88%**		2,181	93	2,046	11,663
10	>1k lines (a)	1,102,702	4%	24,965,452	**92%**	1230	891	285	3,276	7,621
11	>1k lines (b)	1,149,607	4%	26,115,059	**96%**		935	23	3,276	7,972
12	<1k lines (a)	438,430	2%	26,553,489	**97%**	2302	190	61	5,578	4,760
13	<1k lines (b)	702,971	3%	27,256,460	**100%**		305	6	5,578	4,886
	Total	27,256,460				5578	4,886			

Source: Analysys Mason (2008).

BT announced that its actual commercial FTTC roll-out will cover 19mn premises (ca. 70% of premises), 1700 MDF and "tens of thousands of cabinets"[24]. Mapping of actual BT roll-out regions to the geotypes was beyond the scope of this study. Therefore, assumptions had to be made over which geotypes values for the average representative MDF were to be derived. The chosen option was to include geotypes in the order shown in Table 3-1 until roughly 1700 exchanges / 70% of premises were gathered. Because of the core ('a') / wider area ('b') distinction within the available data it was decided to include the first 9 geotypes, i.e. all exchanges with more than 3000 lines, so that the last geotype (>3000 lines per exchange) can be considered as a whole (">3k lines (a)" and ">3k lines (b)").

Alternatively, the selection could have been done giving priority to higher customer density areas (choosing the 'a' geotypes first i.e. those areas close to the exchange which would result in fewer km duct and fewer cabinets). However, gathering around 70% of premises this way requires deploying over 3200 MDFs which is nearly double the communicated actual target number of 1,700. Also it appears generally preferable to use both 'a' and 'b' geotypes of the same category when deriving averages because averaging is more difficult when considering only one of them.[25] In addition, deploying only for the "core half" of an exchange can make marketing of services marginally more difficult.

Both options have been shown in Table 3-2 along with data based on the first five geotypes and all geotypes for comparison. The goal of this exercise was to determine the average values in the shaded cells as inputs for the cost model. Given the uncertainty of mapping BT's rollout to the available network data the chosen option reasonably matches the number of exchanges and the number of premises per exchange.

24 According to BT's press release from February 2013.

25 For example ">3k lines (a)" and ">3k lines (b)" share the same number of exchanges, adding just the (a) geotype to the averaging would add all exchanges but only some of the cabinets to the base for averaging.

Table 3-2: Rough match of BT roll-out information to Analysys Mason / BSG geotype data

Data base	Premises	% of total premises	exchanges	cabinets	avg. premises per ex-change	avg. cabinets per ex-change	avg. premises per cabinet	avg. feeder length / cabinet (m)*
Target from BT press release	ca. 19,000,000	(70%)	ca. 1,700	"10s of 1000s"	(11,176)			
Base over first 9 exchange types (chosen database)	23,862,750	88%	2,046	74,684	11,663	37	320	1,154
Base over 7 densest exchange geotypes (not addressing 'b' types)	18,476,421	68%	3,276	49,927	5,640	15	370	689
Base over the first 5 geotypes	12,003,871	44%	637	25,181	18,844	40	477	1,250
Base over all 13 geotypes (=national average)	27,256,460	100%	5,578	90,001	4,886	16	303	1,144

* derived as total feeder length divided by number of cabinets (Fig. A.2 in Analysys Mason (2008))[26]

Source: Analysys Mason / WIK

With average values of 11,663 premises per exchange, 37 cabinets per exchange, 320 premises per cabinet and 1,154m per feeder segment it was assumed in the model that 1,650 exchanges were to be deployed with FTTC to roughly match the commercial roll-out scope and passing 19,244,153 homes. This was deemed a good fit with the announced coverage goals. Under these assumptions approximately 69,000km of fibre cables are deployed in the model which compares with "more than 50,000km" stated in BT's press release. Circa 60,000 cabinets are upgraded in the model ("tens of thousands" of cabinets according to BT). Given the uncertainties of the underlying data this appears to be a realistic basis.

It can be observed that the national average of the feeder length is slightly lower than the average over the first 9 exchange types that cover 88% of premises. When analysing geotype data from the Analysys / BSG 2008 study in their order (by the number of lines per exchange and comparing geotypes as a whole (viewing averages based on the total exchange area including both the ‘a’ and ‘b’ part, i.e. the dense center and the outer parts of exchange areas) one observes the average length per cabinet shown in the table below.

26 Feeder length in the remaining exchange types is slightly lower which explains why the national average is also slightly lower.

Table 3-3: Average feeder length

Geotype name	feeder length per cabinet (m)	% of premises	% of premises cumulated
Inner london	798	5%	5%
>500k pop	1,111	12%	17%
>200k pop	1,096	10%	27%
>20k lines (a+b)	1,544	17%	44%
>10k lines (a+b)	1,005	22%	66%
>3k lines (a+b)	1,144	22%	88%
>1k lines (a+b)	396	8%	96%
<1k lines (a+b)	n/a	4%	100%

Source: Analysys Mason 2008

This shows that feeder length does not increase steadily from geotype to geotype. Also, the ">10k lines" and ">3k lines" exchange types hold 44% of all British customers so their weight is bigger when determining averages (feeder length Averages were determined by dividing the total number of meters in the feeder segment by the total number of cabinets). This explains why the national average is lower than the average over 88% of premises.

According to the Office of National Statistics[27] there is expected to be growth in household numbers of around 220,000 per year until 2033. Growth may manifest itself as completely newbuilt areas or as infill (e.g. new homes on existing streets, conversion of existing houses into flats). In the first case, for newbuild, it is likely that FTTP would be deployed.. In the second case it is fair to assume that no changes to the number of cabinets are required, but additional lines could be used within them. Given the small absolute increase in homes per MDF (see below) and for the sake of simplicity it was decided to assume that no additional cabinets were required.[28]

In the cost model this growth has therefore been factored in by allowing for a 0.8% per annum increase in the number of lines per MDF between 2013 and 2020 (a conservative estimate given that ONS projects growth over a longer timeframe). This leads to the following estimated parameters for 2020.

27 Household Projections, 2008 to 2033, England https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6395/1780763.pdf

28 If household growth would require new cabinets to be built this would result in more cabinets per MDF which would lead to further investment in feeder networks. Whether this leads to a cost increase or decrease depends on the change in the average number of premises per cabinet.

Table 3-4: Assumptions on averaged network parameters and impact of household growth

	basic assumptions (based on Analysys Mason / BSG)	modified by household growth
Total lines all of UK	27,256,460	29,050,506
Considered Roll-out area		
Total MDF	1,650	1,650
Average number of lines per MDF	11,663	12,431
Total lines	19,244,153	20,510,822
cabinets	60,229	60,229
lines per cabinet	320	341

The overall effect of this assumption is that the fixed cost of GEA provision remains constant (as there are no additional cabinets) and only the variable costs for DSLAM ports increase in line with household growth.

3.2 Investment and cost at the street cabinet

The cost items at the street cabinet included in the model are:

- New cabinet including tie cable and power connection
- VDSL DSLAM (including the associated energy cost), patch cable and splitter[29]

A new cabinet is installed in addition to the existing street cabinet. The total cost of the cabinet, power connection, tie cable including further works such as plinth were assumed to be £5,200. This corresponds to the value suggested by the Bit Commons.[30] A sensitivity was conducted based on a cost of £9,000, which is the value used in the 2008 Analysys Mason study for the BSG. The lifetime of the cabinet has been set at 20 years. A sensitivity for a lifetime of 40 years has also been calculated.

VDSL DSLAM costs have been split between the plug-in unit (£3,000) and a cost per port (£16.67) for a device that hosts up to 256 ports, i.e. an investment of £7,268 for a fully loaded unit (or £28 per port)[31]. This means that for every cabinet an investment of £3,000 is accounted for, plus an additional investment of £16.67 for each active sub-

29 Even with SFBB voice is routed the traditional path

30 The Bit Commons is an independent consultancy which has made contributions to the BDUK requirements for the rural NGA programme and the formulation of the 4G coverage obligation. It has made available a cost calculation tool for public authorities to estimate the cost of FTTC. www.thebitcommons.com

31 In practice DSLAMs will not be fully loaded.

scriber. One DSLAM plug-in unit per cabinet is always installed and it was assumed that one plug-in unit will always be sufficient.[32]

The lifetime of the equipment has been set at 8 years. OFCOM has been using 5 years (Fixed Narrowband Market Review: NGN Cost Modelling) and 10 years (WBA Charge Control) for DSLAMs/MSANs. These lifetimes have also been used in sensitivities.

In the 2008 Analysys Mason study for the BSG an investment of £1,200 was assumed for a 24 port VDSL DSLAM (£50 per port). Given subsequent trends in equipment costs, this is likely to be an excessive figure. However, a sensitivity has been calculated for a 50% increase in DSLAM costs.

Investment costs per splitter at the cabinet has been assumed at £3.33 ,with a lifetime of 8 years (matching the active equipment).

Energy cost was determined using prices from Openreach at £0.1151 per kW for usage and £16.08 per kW p.a. for provisioning. An energy consumption of 1.65W per port was used.

3.3 Investments into the feeder segment

The cost items in the feeder segment between the cabinet and the MDF taken into account in the modelling are

- Duct space
    - For existing ducts only the cost of installing fibre is considered, since the duct cost is already fully accounted for in other wholesale products.
    - For new ducts the investment for deploying the duct is considered; these costs depend on the terrain type.
- Fibre cable and installation

Fibre cable investment including installation in ducts has been assumed at £2.75 per metre with a lifetime of 20 years. A sensitivity has been conducted for an investment of £6 per metre and a lifetime of 40 years. The lifetime of cables is given as 3 to 25 years in BT's annual report. 20 years to 40 years are values found in other cost models from other countries.

Where existing ducts can be reused for fibre deployment between MDF and street cabinet no investment has been allocated (due to the current cost accounting framework). This is consistent with Ofcom’s approach to MPF and WLR charges whereby the whole

32 Given an average number of premises per cabinet of 320 a second plug-in unit would only be required for take-up rates in excess of 80%.

cost of the duct is recovered from MPF / WLR and none is recovered from SMPF or GEA[33].

The investment cost for deploying new ducts has been determined as follows: Investment per meter for deployment on different terrains has been assumed to be £100 on roads, £60 on footpaths and £40 on grass verge.[34] The proportion of fibre installed in the different terrain types was taken from the 2008 Analysys Mason study for the BSG.[35] From the average deployment cost per metre per cluster, an overall average was derived by weighting each cluster with the total length deployed. This leads to an average cost per metre of £57.52. A sensitivity was conducted based on £71.90 per metre, reflecting a 25% increase over the base case value.

A lifetime of 40 years has been applied for ducts which is consistent with both BT's 2012 annual report and OFCOM's LLU charge control, as well as with many other international cost models. A lifetime of 40 years for ducts is also recommended by the European Commission.[36]

Generally, information on the free duct space in BT's network is limited. However, there are two studies by Analysys Mason that address degree of duct reuse. In the 2008 study for the BSG ("The costs of deploying fibre-based next-generation broadband infrastructure") a duct reuse of 80% is assumed. In its 2009 study "Telecoms infrastructure access – sample survey of duct access" for Ofcom the analysis shows that 78% of duct-ends have space for a new 25mm subduct. This gives some indication of re-use potential although it does not necessarily mean that the full length is usable for example because of congestion in duct nests or collapsed sections of ducts that cannot be determined from analysing duct-ends alone.[37] Therefore we have decided to use a base case with 70% duct-reuse. This factor was then sensitized at 80% and 50% (the level assumed in CSMG's 2010 study[38] when deploying fibre to the premises (FTTP). It should be noted however that one would expect a much lower level of duct re-use for FTTP since there will be much lower ability to re-use d-side duct than e-side duct which is required for FTTC).

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33 http://stakeholders.ofcom.org.uk/binaries/consultations/fixed-access-markets/summary/condoc.pdf

34 These assumptions are taken from Analysys Mason’s 2008 report for the BSG.

35 See Analysys Mason (2008) Fig. A.3.

36 European Commission (2012): Draft recommendation on consistent non-discrimination obligations and costing methodologies to promote competition and enhance the broadband investment environment. http://ec.europa.eu/information_society/newsroom/cf//document.cfm?doc_id=1254

37 In their 2009 study "Telecoms infrastructure access – sample survey of duct access" Analysys Mason notes the following reasons why unoccupied duct-end space does not directly translate into useable duct space: Duct nets may be too congested to have access to an empty duct at the bottom. Ducts might have collapsed in the middle of a section. Cable arrangements in the duct may be such that existing cable cross-over may prevent further cables being inserted.

38 CSMG (2010): "Economics of Shared Infrastructure Access" http://stakeholders.ofcom.org.uk/binaries/consultations/wla/annexes/csmg.pdf

3.4 Investments and cost at the exchange

The following cost items have been considered in this category:

- Optical Distribution Frame (ODF)
- Ethernet Switch
- Space, power, energy consumption, tie cabling etc. All of these have been approximated through the "Co - Mingling Medium Capacity Unit MCU-1" wholesale product

The DSLAMs at the cabinets are backhauled with fibre cables and connect to the exchange. These fibres are terminated at a passive Optical Distribution Frame (ODF) at the exchange. An investment of £50 per port has been assumed which covers both sides of the ODF and the patch cable in between. This compares to £40 per connection in the 2008 Analysys Mason study for the BSG. A 50% cost increase has been used as a sensitivity to this assumption. The ODF lifetime was assumed to be 20 years, and a sensitivity was conducted for 40 years.

The Ethernet switch was scaled to account for the fact that on average fibre from 37 DSLAMs is terminated at one exchange (1 DSLAM per cabinet, 37 cabinets per MDF). The switch investment was taken from OFCOM's 2013 Fixed Narrowband Market Review where the plug-in unit costs £7,000 and one line card with 24 GbE ports costs £4,000. It was assumed that the capacity of this switch is sufficient to manage the traffic from all connected DSLAMs (that is, there is no requirement for a second unit). Accordingly, the switch investment was set at £15,000 (covering a plug-in unit plus two line cards). This yields a price per port of £312 which compares to £1,000 per port in the 2008 Analysys Mason report for the BSG. It should be noted that Ethernet prices could be expected to have fallen significantly since 2008. Nonetheless, a sensitivity was conducted where a more expensive switch (£45,000) from WIK's benchmark database was used.[39]

For the network sided port which is used to hand over the GEA to an access seeker an investment of £1,250 per 10GbE port with a lifetime of 8 years was assumed. This value was derived from OFCOM's Fixed Narrowband Market Review. Two ports per switch were accounted for.

Instead of a detailed determination of all further cost related to colocation at the MDF such as rack-space, Uninterrupted Power Supply, cooling, energy etc. it was decided to use the "Co - Mingling Medium Capacity Unit MCU-1" wholesale product as a conservative approximation using current Openreach price lists (April 2013-March 2014). It is

39 The investment per switch plays a very minor role in determining the total monthly cost per line since it is shared by all users connected to the exchange.

expected that this is a conservatively high cost estimate given that only incremental cost needs to be considered.

A power consumption of 1.5W per switch port was assumed, leading to a requirement of 0.0555kW of power capacity (1.5W x 37 ports) and an annual power usage of 486.18kW. The annual cost determined is shown in Table 3-5 and the total cost of £2,277 is applied as annual cost per exchange in the cost model.

Table 3-5: MCU1 annual cost per exchange

Item	**Cost p.a. (£)**
UPS Rental	211
Security Partitioning	139
Power Dis Rental	421
DC Power	725
Add Rectifers	93
Service Charge	215
Security	91
Room Licence Fees	271
Power Standby	11
Power Usage	44
Internal Tie Cable	24
MDF Licence Fee	32
Total annual cost	**2,277**

The MCU-1 also requires a total investment of £6,854 per exchange for the items shown in Table 3-6.

Table 3-6: MCU1 investment per exchange

Item	**Investment (£)**
Accommodation	3,834
Cooling	98
Handover	312
Access	375
Prov Meter	876
Set-up Fee	967
Tie Cable	391
Total invest	**6,854**

As will be shown later, central costs at the exchange are responsible in total only for a very small share of the total cost.

3.5 Assumptions on the relation between bandwidth and cost

It was assumed that DSLAMs and Ethernet Switches are well suited to deal with the bandwidth and growth in consumed bandwidth per user. For example DSLAMs will on average be utilized by about 170 users and are backhauled through 1Gbps connections to an Ethernet switch. Even at concurrent usage in the busy hour (the hour of the day in which demand is at its peak) this leaves close to 6 Mbps per user backhaul capacity which compares to busy hour capacities of usually less than 0.5 Mbps per user nowadays. Likewise it was assumed that the capacity of the switch which manages 37 DSLAMs is sufficient.

These reasonable assumptions generally decouple the cost of the network from different bandwidth requirements. Even at strong growth of busy hour requirements this dimensioning allows plenty of reserve in the backhaul.

3.6 Further cost parameters

3.6.1 Indirect investments

Assets such as office equipment, general land and buildings etc. are not determined in a direct bottom-up manner. Instead, these "indirect" investments have been determined as percentage of the total direct investment. The percentages used are shown in the following table. They are based on WIK's benchmark database.

Table 3-7: Indirect investment as a percentage of direct investment

Indirect investment category	Percentage of direct invest
Motor Vehicles	2.0%
Workshop Facilities	0.5%
Office Equipment	0.5%
Land and Buildings	0.5%
General IT	1.0%
Other Network Support Equipment	1.0%

3.6.2 Other OPEX

Energy costs and all colocation related cost items have been considered in separate "direct" OPEX positions already explained above. The annual costs of asset maintenance, management and planning were derived as a percentage of the asset's investment value. The percentage values applied are based on various model applications by WIK and are shown in the following table.

Table 3-8: Annual OPEX as percentage of investment

Asset	Annual OPEX in % of investment
Cabinet	2.0%
DSLAMs	8.0%
Fibre cables	1.0%
duct	1.0%
ODF	1.0%
Ethernet Switch	8.0%
Splitter at cabinet	0.5%
DSLAM copper cabling connection	0.5%
"Co - Mingling Medium Capacity Unit MCU-1" as proxy for all colocation related cost at the exchange	5.0%
Motor Vehicles	10.0%
Workshop Facilities	10.0%
Office Equipment	10.0%
Land and Buildings	5.0%
General IT	10.0%
Other Network Support Equipment	10.0%

3.6.3 WACC

The weighted Average Cost of Capital (WACC) for BT's access business is 8.8%. This is the pre-tax nominal WACC applied by OFCOM for the copper access business model in the charge control review for LLU and WLR services.[40]

As to a possible risk premium for the fibre business there are diverging views on whether FTTC, as distinct from FTTP, should be eligible for such a premium. In its original decision in 2008 concerning access to VDSL-based bitstream[41], BIPT applied a risk premium only on passive elements associated with the VDSL deployment - fibre and connectors. This resulted in an uplift of €0.66. However, in 2011, BIPT removed the premium on the basis that FTTx coverage had reached around 80% of the population and returns were being made on the investment[42]. In a report for German regulator

40 see p. 129 in OFCOM (2013) Charge control review for LLU and WLR services Annexes http://stakeholders.ofcom.org.uk/binaries/consultations/wlr-cc-2011/statement/annexesMarch12.pdf

41 https://circabc.europa.eu/sd/d/28e78835-c123-4858-9457-961084f967e2/Analyse%20Mk11Mk12cv%20-%20080123ba1p.pdf

42 https://circabc.europa.eu/sd/d/6258f6e4-8626-4db3-8f0d-25953874f691/M4-5-decision-publication-FR.pdf

Bundesnetzagentur in 2010[43] a difference between the copper and fibre WACC of 2.59% was suggested. However, this was considered relevant only for FTTP. The report suggests that FTTC should not be eligible for such a premium because the risk of FTTC/VDSL is deemed significantly lower than the risk of FTTP. The report argues that the risk profile of FTTC/VDSL corresponds to that of xDSL or cable.[44] Furthermore, the report notes that the beta of Deutsche Telekom AG has actually fallen in the year 2005 and the following years of intense VDSL-rollout. Finally, the study concludes that if the proposal against any risk premium for FTTC was unjustified this would send positive incentives for FTTP deployment and negative incentives for FTTC rollout. which would be less serious than an erring in the other direction.

The Spanish regulator CMT has proposed a risk premium of 4.81% for bitstream services based on fibre[45]. However, it is not clear whether this risk premium would be applicable to services provided on the basis of FTTC.

In this cost estimate, our base case adds a risk premium of 2% for fibre cables and equipment associated with the provision of GEA on top of the current nominal WACC for LLU (8.8%). We also conduct sensitivities for a risk premium of 0% and 4%.

Arguably, the accelerated roll-out and take-up rates of SFBB by VM and BTR's customer-base imply that the demand-risk for SFBB is at the lower end of the scale in the UK. Reported Capex by BTOR[46] has also been relatively stable in recent years suggesting that FTTx investment may to some extent have replaced or complemented previous investments in copper infrastructure. This would be supportive of a lower or even no risk premium.

No risk premium is assumed for ducts in the base case on the basis that they may be used for purposes besides GEA and it is not clear the extent to which ducts may have been replaced or refurbished in the absence of an FTTC programme. However, we include a sensitivity in which newly built ducts for GEA are also subject to the same risk premium as fibre cables and equipment[47].

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43 See p.26. in Stehle (2010) http://www.bundesnetzagentur.de/cae/servlet/contentblob/194320/publicationFile/9936/Gutachten

44 See p. 14 / 15 in Stehle (2010)

45 http://blogcmt.com/2013/03/06/la-cmt-aprueba-la-prima-de-riesgo-para-la-fibra-optica/#more-32279

46 BT quarterly results http://www.btplc.com/Sharesandperformance/Quarterlyresults/Quarterlyresults.htm

47 If some ducts may have been refurbished irrespective of an FTTC programme and may be used for other purposes a risk uplift of 2% for all NGA-related investments including ducts might be considered excessive. An alternative approach towards the WACC and the treatment of ducts could be to include ducts but set the premium to 1%. Under this approach, the outcome is not significantly different from the base case.

Table 3-9: Assets eligible for fibre risk premium

Asset	Eligibility for premium
Cabinet (complete)	yes
DSLAMs	yes
Fibre cables	yes
Ducts	no
ODF (both ports and patch cable)	yes
Ethernet Switch	yes
Splitter at cabinet	no
DSLAM copper cabling connection	no
"Co - Mingling Medium Capacity Unit MCU-1" as proxy for all colocation related cost at the exchange	no
Motor Vehicles	no
Workshop Facilities	no
Office Equipment	no
Land and Buildings	no
General IT	no
Other Network Support Equipment	no

3.6.4 Common Cost

Common cost are cost on the level of administration and management that cannot be allocated to individual services. Examples for common cost are human resources, strategy / regulatory departments, research or more specific costs such as (wholesale) billing, (wholesale) sales, (wholesale) order management, (wholesale) customer acquisition.

Common cost cannot well be modeled through bottom-up cost models, e.g. by rebuilding concrete cost driving activities of administration and management, because there is usually not enough information to do so. Furthermore, common cost depend on the company's degree of integration. Economic theory (especially Coase / Williamsen) says that there cannot be judgements on efficiency regarding such integration. Therefore, it is not only very difficult but also not advisable to determine common cost in a bottom-up manner. Instead, mark-up factors are applied on CAPEX and OPEX as a pragmatic approach.

In this study annual common cost was derived as 10% of annual CAPEX and OPEX. This is a value from WIK's benchmarking database.

3.6.5 CAPEX and OPEX price trends

Annual price trends for the assets were chosen to be roughly in line with the nominal price trends in OFCOM's 2013 Fixed Narrowband Market Review. The average annual price trend is the same for the respective OPEX positions.

Table 3-10: Nominal CAPEX / OPEX price trend

Asset	Chosen value	OFCOM NCC
Cabinet	1.0%	
DSLAMs	-5.0%	-5%*
Fibre cables	-3.0%	-3%
Ducts	-1.0%	-3%
ODF	-0.5%	-1%
Ethernet Switch	-5.0%	-5%
Splitter at cabinet	1.0%	
DSLAM copper cabling connection	1.0%	
"Co - Mingling Medium Capacity Unit MCU-1" as proxy for all colocation related cost at the exchange	1.0%	
Motor Vehicles	1.0%	
Workshop Facilities	1.0%	
Office Equipment	1.0%	
Land and Buildings	2.0%	2%
General IT	-4.0%	
Other Network Support Equipment	1.0%	

* the value for "active equipment" was taken as reference.

Sensitivities were conducted around the annual duct price trend, based on trends of +1% p.a. and -3% p.a.

The direct OPEX price trend for the MCU1 and for energy cost was assumed to be +2% p.a.

3.7 Timeframe, reinvestments, present value and economic depreciation

The model considers a timeframe of 60 years. Upon reaching the end of an asset's life-time it is replaced causing new investment at the prevailing price. The stream of in-vestments was discounted to present value with the nominal WACCs. No terminal value was considered with a timeframe of 60 years being considered sufficiently long that cost at the end of the consideration period becomes practically immaterial through discount-ing. Investments (and OPEX) are recovered over the full (project) timeframe of 60 years, not over their individual lifetimes.

Generally, the present value of all amortisation payments must equal the present value of the investment stream over the consideration period of 60 years. Cost recovery is modelled on the assumption that depreciation needs to be in proportion of customers and that it needs to reflect the cost profile. Accordingly, amortisation payments for CAPEX and OPEX were derived through economic depreciation, under which amortisa-tion is scaled according to the network's output, the subscribers, accounting for changes in asset prices. This made sure that if an asset is expected to have a higher nominal cost in the future the cost per unit (per line) in future periods reflects this (since cost-based prices serve as make-or-buy signals for potential market entrants). Therefore, positive price trends back-load amortisation, making the cost per line higher in later periods (and vice versa for negative price trends). All reported cost values are given in nominal terms unless explicitly stated otherwise. The calculation was done separately for each asset and for CAPEX and OPEX.

The mathematical approach used is as follows:

The investment stream of an asset over n years is discounted to its present value *I* using the interest rate *i*.

$$I = \left[\frac{I_1}{(1+i)} + \frac{I_2}{(1+i)^2} + \frac{I_3}{(1+i)^3} + \cdots + \frac{I_n}{(1+i)^n}\right] \qquad (1)$$

The discounted value of all amortisation payments A_1 to A_n must equal the present value of investment *I*. This is shown in formula (2).

$$I = \left[\frac{A_1}{(1+i)} + \frac{A_2}{(1+i)^2} + \frac{A_3}{(1+i)^3} + \cdots + \frac{A_n}{(1+i)^n}\right] \qquad (2)$$

Asset price changes are considered through an average annual price trend Δp. The input asset price *p* of a given period *t* can be derived as

$$p_t = p_1(1+\Delta p)^{t-1} \qquad (3)$$

With Q_t being the output in period *t* the amortisation payment of a given period *t* is defined as

$$A_t = Q_t p_t \qquad (4)$$

With (3) and (4), formula (2) can be converted to the following equation

$$I = \left[\frac{Q_1 p_1}{(1+i)} + \frac{Q_2 p_1 (1+\Delta p)^1}{(1+i)^2} + \frac{Q_3 p_1 (1+\Delta p)^2}{(1+i)^3} + \cdots + \frac{Q_n p_1 (1+\Delta p)^{n-1}}{(1+i)^n}\right] \qquad (5)$$

By factoring out $p_1 Q_1$ the following equation can be derived

$$I = p_1 Q_1 \left[\frac{1}{(1+i)} + \frac{\frac{Q_2}{Q_1}(1+\Delta p)^1}{(1+i)^2} + \frac{\frac{Q_3}{Q_1}(1+\Delta p)^2}{(1+i)^3} + \cdots + \frac{\frac{Q_n}{Q_1}(1+\Delta p)^{n-1}}{(1+i)^n}\right] \qquad (6)$$

The numerator of each summand in the brackets of equation (6) can be interpreted as the level of output relative to the output level in the first period with an adjustment for asset price trends.

Using equation (4) this can be slightly simplified as

$$I = A_1\left[\frac{1}{(1+i)} + \frac{\frac{Q_2}{Q_1}(1+\Delta p)^1}{(1+i)^2} + \frac{\frac{Q_3}{Q_1}(1+\Delta p)^2}{(1+i)^3} + \cdots + \frac{\frac{Q_n}{Q_1}(1+\Delta p)^{n-1}}{(1+i)^n}\right] \quad (7)$$

All elements for determining the amortisation payment in the first period are known (*I*, Q_t, Δp) so A_1 can be determined as shown in (8).

$$A_1 = \frac{I}{\left[\frac{1}{(1+i)} + \frac{\frac{Q_2}{Q_1}(1+\Delta p)^1}{(1+i)^2} + \frac{\frac{Q_3}{Q_1}(1+\Delta p)^2}{(1+i)^3} + \cdots + \frac{\frac{Q_n}{Q_1}(1+\Delta p)^{n-1}}{(1+i)^n}\right]} \quad (8)$$

The amortisation payments for all periods can be determined by multiplying the derived value for A_1 with the respective level parameter of period *t*

$$A_t = A_1 \frac{Q_t}{Q_1}(1+\Delta p)^{t-1} \quad (9)$$

4 Penetration forecasts

Calculating costs on the basis of economic depreciation depends critically on developing reliable forecasts for penetration of FTTC. We have developed a penetration model which incorporates actual roll-out and take-up values from 2010-2012, and thereafter makes projections based on past experience in the UK and in other comparable European markets concerning the take-up of superfast broadband.

There is an interdependence between penetration and the pricing of wholesale products, because excessive wholesale charges could either result in retail charges being higher than they might optimally be to maximise penetration, or could limit competition in SFBB, which is also likely to have a dampening effect on take-up overall. An implicit assumption within the penetration model is therefore that wholesale charges are set at a reasonable level that permits effective competition and avoids excessive retail charges. We have cross-checked the results of applying these penetration forecasts to the cost model, and believe that they are consistent with a wholesale price premium of between £4.00-£5.50 resulting in a retail price premium (ex VAT) at similar levels.

4.1 Modelling approach

The model describes the expected evolution of the broadband market as a whole and the market position and share of each of the main telecoms operators within it on standard and superfast broadband (SFBB).

4.2 Market size

The size of the broadband market is determined by household growth and the proportion of households subscribing to broadband. The starting assumption concerning numbers of relevant premises is drawn from the 2008 Analysys Mason report[48], which also provides parameters concerning network structure for the GEA cost estimate[49]. We have provided for a small year on year increase in numbers of premises of 0.8% until 2020 on the basis of projections from the Office of National Statistics (ONS) suggesting an increase of 220,000 households annually[50].

We also provide for a small annual increase of 0.8% until 2020 in household penetration of broadband. This would take penetration rates up from around 80% today to a maximum of 86%.

48 "The costs of deploying fibre-based next-generation broadband infrastructure"; http://www.broadbanduk.org/2008/09/05/bsg-publishes-costs-of-deploying-fibre-based-superfast-broadband/

49 It is possible that the Analysys Mason figures could underestimate the number of current premises due to household growth since the 2008 report.

50 Household Projections, 2008-2033, England https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6395/1780763.pdf

4.3 Market shares

Within the broadband market as a whole, operators (distinguished between Virgin Media (VM), BT Retail (including BT Plusnet) (BTR) and others) are assumed to maintain their current overall market shares.[51] This is based on the assumption, which is essential when making forecasts for markets which are subject to SMP regulation, that the wholesale market is regulated and/or prices/margins are set in a way which enables retail competition to be sustained. If this does not happen then take-up of SFBB is likely to be lower and BTR's share higher. Operators other than BT and Virgin are assumed to use BT wholesale products (from BT Openreach or BT Wholesale). The combined customer base of BTR and non-BTR as listed in the model are referred to as the BT Openreach (BTOR) customer base.

For the purposes of calculating the relevant customer base eligible for SFBB per operator (see below), we also assess relative market shares for all broadband within and outside cable areas. Within cable areas, we estimate that VM had 44% market share end December 2012 with BTOR accounting for the remainder. Outside cable areas, we assume that BTOR has 100% market share.

We assume that the distribution of market shares between BT and non-BT retail operators on the BTOR platform is the same within and outside cable areas with BTR maintaining 38% market share on the BTOR platform.

4.4 NGA coverage

We assume that the entire cable network has been Docsis enabled since 2010. Coverage figures for Docsis (45% households) are based on end 2011 figures from the 2012 Point Topic report for the European Commission[52]. Household coverage of the BT FTTx network is based on BT's existing and planned coverage as reported in BT financial statements and press releases. BT's commercial roll-out of 19m homes (approx. 70% of households) is assumed to be completed in Spring 2014[53].

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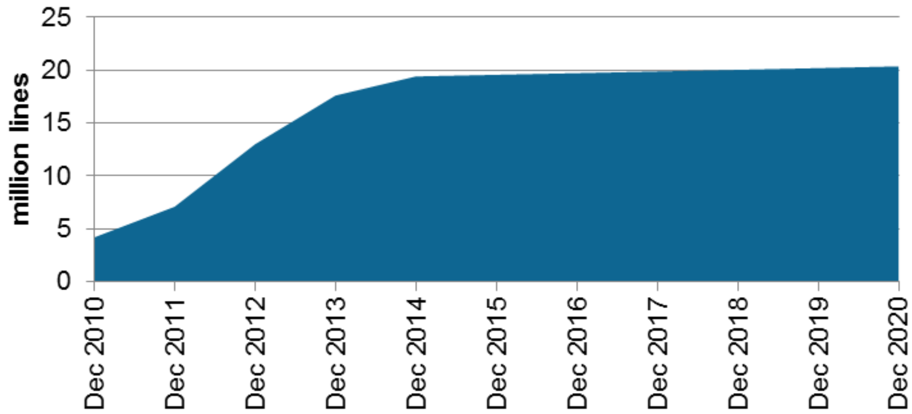
51 Note that these are quite different from current market shares in SFBB, where BTR has a very high market share, and other ISPs correspondingly low market shares.

52 https://ec.europa.eu/digital-agenda/en/news/study-broadband-coverage-2011-updated

53 BT press release 12 February 2013 http://www.btplc.com/news/Articles/ShowArticle.cfm?ArticleID=23F28D29-F8B5-4EC0-A3F8-04C1FEA340F1

Figure 4-1: FTTx households passed (commercial)



The model can readily deliver forecasts based on the higher coverage of 90% households served by FTTx which will be reached with additional support from Broadband Delivery UK (BDUK) financing. This is helpful in displaying how the market may evolve in practice. However, the GEA cost model and associated penetration projections are based only on BT's commercial roll-out (ie 19m homes circa 70% households) due to uncertainties over the amount of any BDUK and other subsidies awarded for additional coverage.[54]

4.5 Overlap of NGA coverage

It is notable from available data for 2011[55] that BT has not in practice concentrated its FTTx roll-out in Docsis-enabled areas. Data instead implies that 48% of BT's FTTx coverage in 2011 was outside Docsis areas. This may appear counterintuitive, as in other countries FTTx deployment has often begun as a response to competition from Docsis. However, it could be rational for BT if it expects to achieve greater take-up of GEA on the FTTx platform in areas where cable was not present, due to absence of infrastructure competition giving it essentially 100% platform share in such areas.

For the model, our central assumption is that BT will continue to roll out some FTTx infrastructure outside Docsis areas in 2013, but that from 2014 onwards, its focus will be to complete its coverage largely within Docsis areas such that it achieves 95% FTTx coverage in cable areas during 2014. This would result in the overall commercial coverage of NGA (Docsis and FTTx) in the UK reaching 72%. This assumption is based on

54 Such subsidies would need to be netted off the costs of roll-out in subsidised areas when determining the appropriate price level for GEA.

55 Point Topic 2012 for European Commission https://ec.europa.eu/digital-agenda/en/news/study-broadband-coverage-2011-updated the premise that BT would ultimately need to match speeds offered by Docsis in cable areas to avoid losing market share in such areas.

We also model an alternative scenario in which BT continues its previous pattern of deployment and focuses a significant proportion of its investment in non-cable areas. This scenario makes use of a pareto curve calibrated on the basis of actual data concerning overlap in 2011 to determine the proportion of BT's roll-out in cable vs non-cable areas. If coverage is maximised at 70% (the commercial coverage – not taking account of any additional subsidised coverage via BDUK), this scenario would result in BT covering 72% of Docsis areas with FTTx. Total commercial (non-subsidised) NGA coverage including FTTx and Docsis in this case would be 83%. If the higher (90% coverage) roll-out of FTTx is assumed, BT would cover 91% of Docsis areas and total commercial coverage would reach 94%.

4.6 Potential customer-base for SFBB

Broadband customers are assumed to be evenly distributed across the UK. Estimates of broadband customers served by each of the operators within SFBB-enabled areas (respectively Docsis and FTTx) are calculated on the basis of broadband penetration within the SFBB-enabled area and the relevant market shares for each operator.

4.7 Customer take-up of SFBB in served areas

A central assumption in the model, which drives the projections of total uptake of SFBB across the UK, is the percentage of broadband customers in SFBB-enabled areas from each operator which are taking up SFBB. For Virgin Media (cable), it is clear from financial statements that there is an active strategy of forced migration of existing customers to SFBB (at no extra charge). This has resulted in more than 50% of VM's customer base taking SFBB by the end of 2012[56]. We assume that the proportion of VM's customer base taking SFBB will increase by around 10% per year and reach 100% by 2017. This assumption has no direct impact on GEA take-up or costs.

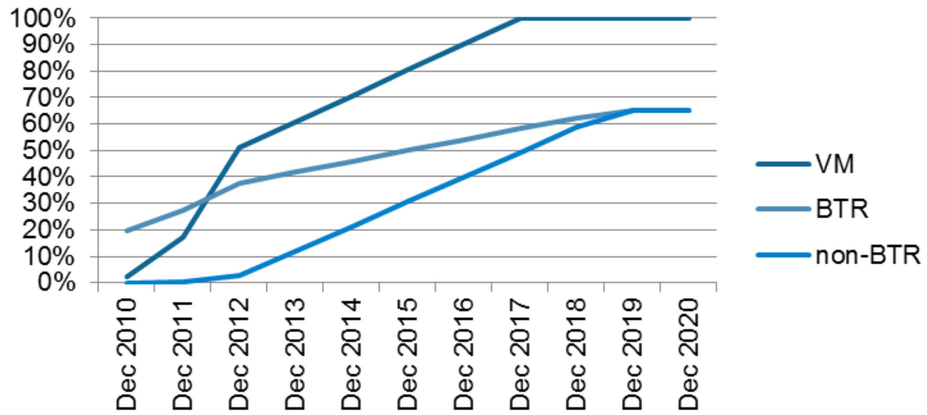
Based on actual data, we estimate that at the end of 2012, 38% of BT retail broadband customers in areas served by FTTx were taking SFBB. However, due to low take-up of GEA by BT's competitors, only 16% of BTOR customers in the relevant areas were taking SFBB.

In our base-case scenario we assume that uptake of SFBB by BTR and other operators on the BTOR platform will increase gradually such that it reaches a maximum of 65% of addressable broadband customers by 2019. In practice this would mean a gradual

56 http://phx.corporate-ir.net/External.File?item=UGFyZW50SUQ9MTcwNDIwfENoaWxkSUQ9LTF8VHlwZT0z&t=1

catch-up over 6 years by BT competitors with relatively slow growth in BTR's SFBB take-up. The estimate of 65% maximum conversion rate for broadband customers within the FTTx footprint could be viewed as a conservative assumption given competitive pressure by cable to move customers to SFBB services. In our high scenario we assume 80% conversion by 2020, whilst the low scenario assumes 50% conversion of BTOR customers in served areas.

Figure 4-2: % eligible BB customers taking SFBB (base case)



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4.8 Outputs

The results of the model are summarised in tables and charts in order to enable the results to be effectively cross-checked.

Figure 4-3 shows the expected take-up of superfast broadband as a proportion of passed households and eligible broadband customers and all households and broadband customers. We project that by end 2014 41% of broadband customers within the FTTx/Docsis footprint will take superfast broadband, whilst 73% take-up could be achieved by end 2020. This is based on aggressive assumptions concerning Docsis take-up (where more than 50% take-up by eligible customers has already been achieved) and more modest assumptions of 65% conversion by 2020 of BTR customers and other customers on the BTOR platform.

Figure 4-3: Percentage of customers taking Super Fast Broadband

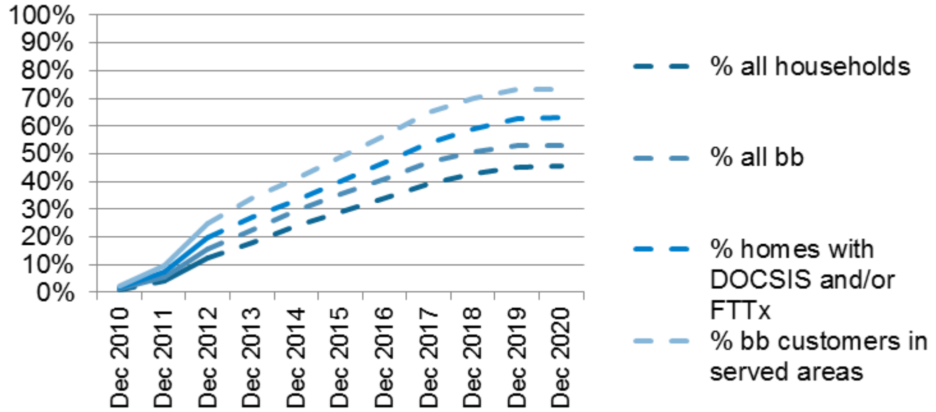
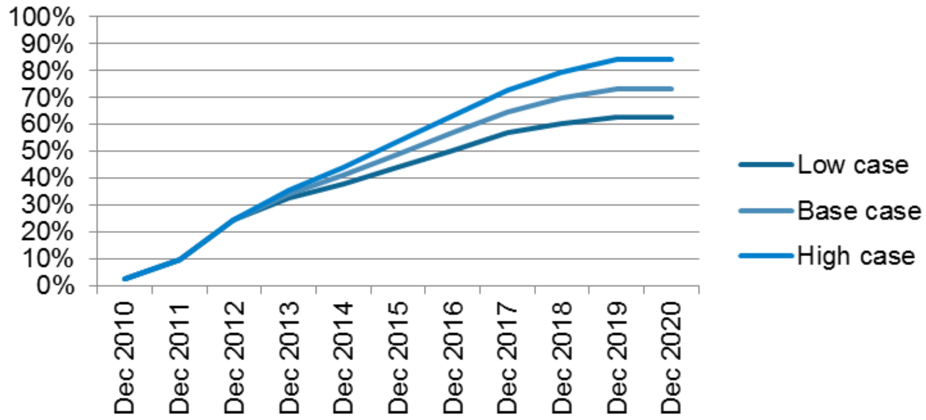
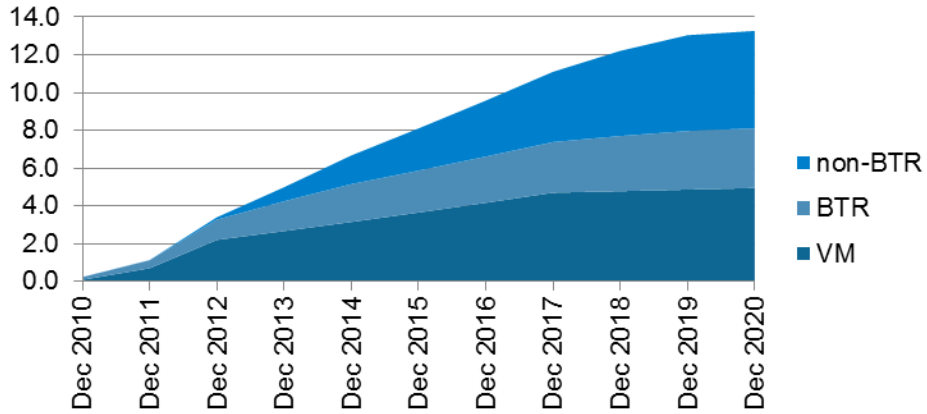


Figure 4-4: Super Fast Broadband customers as percentage of broadband customers in served areas



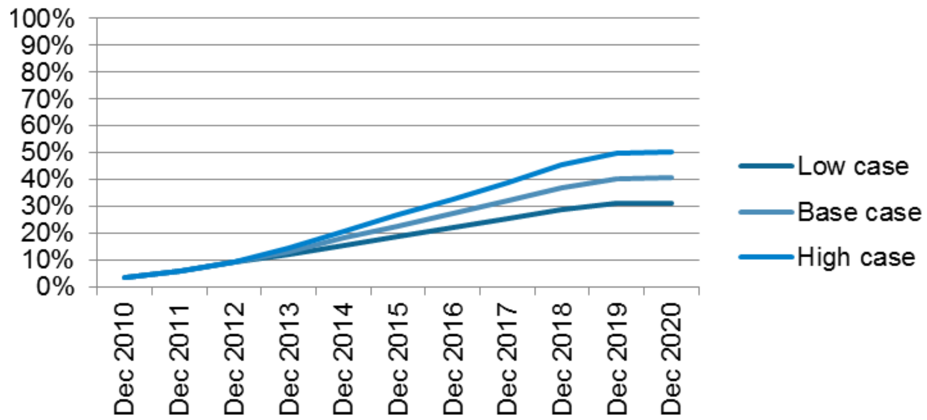
The resulting market growth and split in market shares is shown in the chart below. Approximately 13m customers are projected to take superfast broadband by Dec 2020 on the basis of these projections. This would grow to approx. 16m customers if FTTx coverage reaches 90% with the support of BDUK funding.

Figure 4-5: Super Fast Broadband lines by operator



The primary output from the penetration forecast which is used for the estimation of costs in the cost model is the take-up of GEA as a proportion of FTTx households passed. It is important to note that the apparent growth in GEA take-up in the base and high cases assumes usage of GEA by non-BT operators on the BTOR platform, which in turn is predicated on reasonable conditions including cost reflective prices and no margin squeeze for the GEA product. Wholesaling could in this context be viewed as a positive growth opportunity for this platform which reduces overall risk for the investment made.

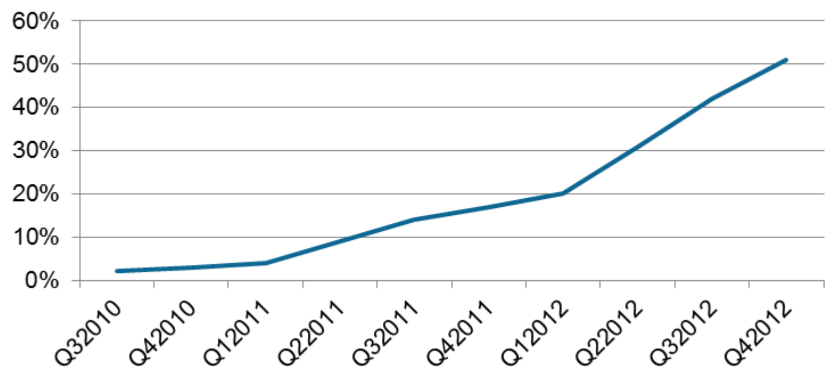
Figure 4-6: Take-up of GEA as percentage of FTTx homes passed



4.9 UK benchmarks

Historic trends from the UK have been used to inform the forecast wherever available. Trends in take-up on Virgin Media's Docsis platform and BT's FTTx platform have been informative. In a period of just two years ending December 2012, VM's SFBB (> 30 Mbps) customer-base increased from 3% of its broadband subscribers to 51%. In its quarterly report for Q2 2012[57] BTR reported that more than half of new customers were choosing SFBB products, resulting in 14% of its retail customer-base taking SFBB as of September 2012, despite coverage of the FTTx platform reaching only around 33% of households at that stage.

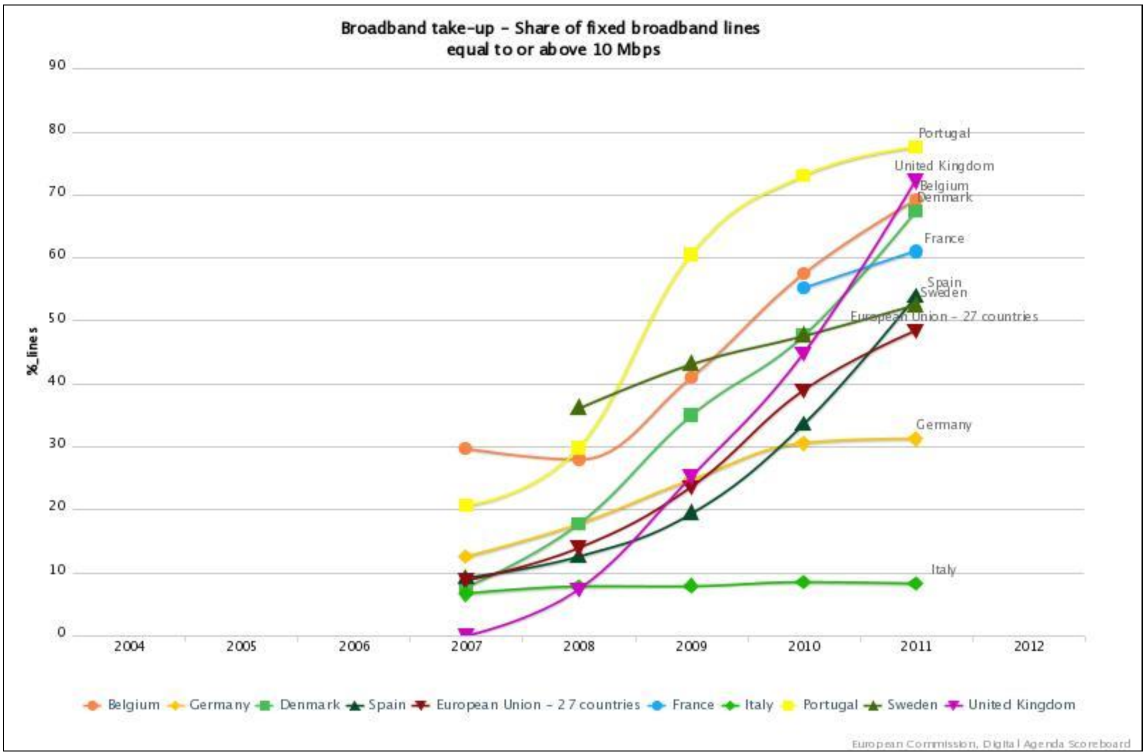
Figure 4-7: Percentage of Virgin Media customer base on Super Fast Broad-band



Another sign that British customers may be open to taking higher-speed services is the historic take-up path of 10Mbps in the UK, which achieved 70% take-up within the broadband customer base just 4 years after launch, a faster rate of adoption than in any other European country.

57 http://www.btplc.com/Sharesandperformance/Quarterlyresults/PDFdownloads/q112release.pdf

Figure 4-8: Broadband take-up – Share of fixed broadband lines equal to or above 10 Mbps



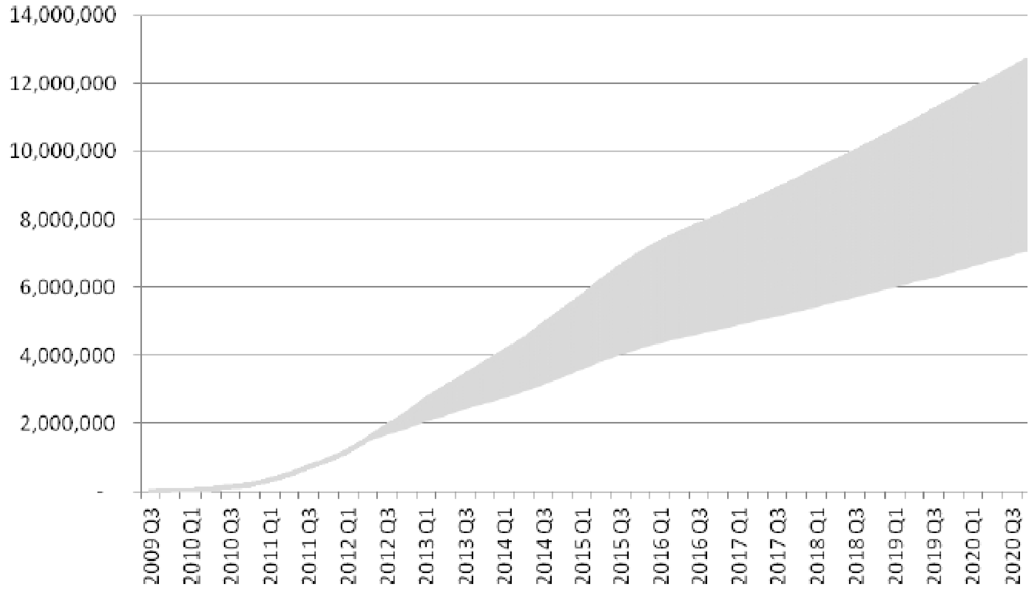
We are aware of one other publicly available forecast of NGA take-up rates, which is the BSG report published in 2012[58] (figure 4-9). This study was based on data available up to Q1 2012 and shows a take-up of 13m lines as an optimistic scenario for 2020. Our comparatively more aggressive forecasts are based on actual data from Q3 2012 (end Dec) which show SFBB take-up at considerably higher levels than the highest forecast suggested by BSG – 3.4m lines in comparison with their projection of just over 2m lines. Virgin Media's observed strategy of concentrating marketing efforts on Docsis SFBB (which they note is a considerably lower cost solution than FTTx/VDSL) may also serve to stimulate competition and accelerate the adoption of SFBB as standard in the UK.

A forecast prepared by Enders Analysis[59] on the other hand projects 17.4m SFBB subscribers by the end of 2017, which is significantly more optimistic than our projection of 13.3m (assuming 90% coverage target), and would represent 73% of all broadband customers. Their assumptions concerning the total number of broadband customers at 2017 match our estimates.

58 Demand for superfast broadband http://www.broadbanduk.org/2012/10/11/demand-for-superfast-broadband-in-the-uk-a-solid-start/

59 Enders Analysis, UK Broadband forecast to 2017

Figure 4-9: Super Fast Broadband subscriber estimate to 2020 – UK



Source: Operator data; BSG estimates

4.10 European benchmarks

European benchmarks from countries with a longer history in NGA deployment are useful in cross-checking the outcomes of modelled projections. Belgium is a particularly useful comparison as VDSL infrastructure (alongside Docsis 3.0) has been in place for some years and reached nearly 80% coverage at the end of 2011[60]. Total NGA coverage in Belgium was reported to be 98% at the end of 2011. Sweden is also relevant as it has had FTTH/B infrastructure in place for some years, which in 2011 covered 35% of the country. Overall NGA coverage including VDSL and Docsis reached around 50%.

The take-up of NGA infrastructure in Belgium was above 50% of all broadband customers at the end of 2011 and was increasing whilst Sweden, with a lower coverage area of NGA, achieved take-up by nearly 30% of broadband customers. Extrapolating Sweden's take-up rate for a 100% coverage of NGA (similar to Belgium) would increase the take-up rate to around 55%.

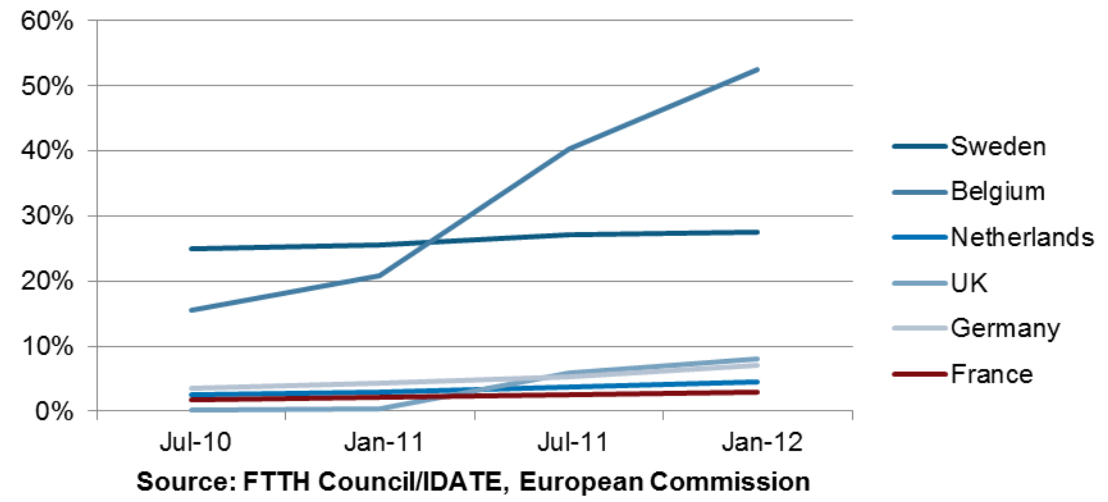
As a proportion of NGA homes passed, Sweden and Belgium achieved 38% and 43% take-up of NGA-based broadband respectively at the end of 2011.

By comparison, at this relatively early stage in NGA deployment, the UK had achieved 20% take-up of SFBB as % served households at the end of 2012. In light of experience

60 Point Topic for European Commission 2012

from Belgium and Sweden which could be described as several years in advance of the UK, it seems reasonable that take-up as a % of served households in the UK could increase to 40% by the end of 2015 and reach 63% by the end of 2020.

Figure 4-10: NGA infrastructure subscribers as percentage of total broadband subscribers



5 Results of the calculation

5.1 Results of the cost model

The cost model in principle provides results for the GEA cost for each year from 2010 (year 1) to 2069 (year 60). For this presentation of the final results it was decided to focus only on the cost per line according to economic depreciation for the year 2013 (year 4). All values reported are nominal values unless stated otherwise.

Applying the base case assumptions laid out in section 3 leads to a **monthly cost per line of £4.39**.

Table 5-1: Monthly cost per line in the base case

Monthly cost per line (£, nominal)	**4.39**
CAPEX per line	3.11
OPEX per line	0.88
Common Cost	0.40

In order to compare the investment requirements in the model with the £2.5bn announced by BT a simple sum of the initial investment for setting up the network once was derived.[61] The model shows a real value for initial investments (without considering any renewals) of £2.25bn which is comparable to BT's announcement.

As stated in section 3 this cost per line and the investment reflects deployment of FTTC at 1,650 MDFs (about 60,000 cabinets) with an average feeder length of 1,154m and for which 70% of ducts could be reused at no cost. The number of passed homes is 20.5m (inflated through household growth from an initial coverage base of 19m) and the number of subscribers converges towards 10.4m (ca. 51% penetration within homes passed). Dividing the initial investment (including line cards for the estimated subscriber base) by the number of passed homes yields a (real terms) investment per home passed of £110.[62]

We assumed in the context of this exercise that BT's stated investment relates specifically to the installation of FTTx and the GEA platform. However, if BT's reported capex also includes investment which is relevant to other platforms, the total attributable to FTTx could be lower.

61 This just counts the necessary investment for all cabinets, ducts, DSLAMs (including all line cards which depend on the subscriber evolution) and so on but does not account for renewals. This value signals the investment to build the network once in 2010 in order to compare it to BT's announcement.

62 In a greenfield sensitivity where duct reuse was set to 0% the investment per passed home increased to £275.

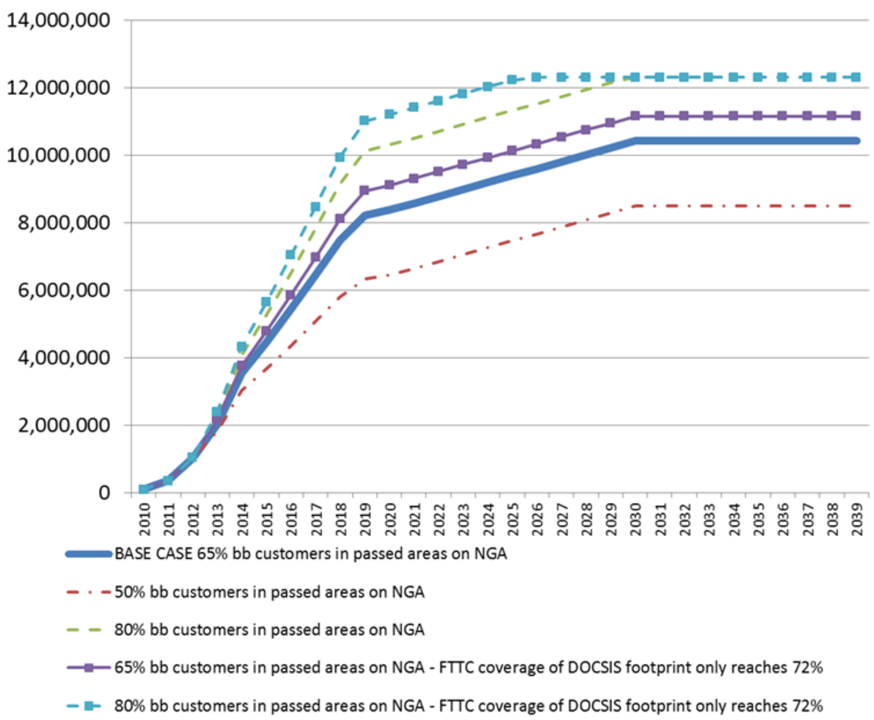
Many sensitivities were carried out in order to determine the impact of varying key parameters and check results. Cleary, some of the most important cost drivers are

- the overall penetration of SFBB;
- the degree of duct reuse;
- and the WACC.

The base case penetration was based on the assumption that 65% of broadband customers on the BTOR FTTC platform would migrate to NGA by 2020. Stand-alone sensitivities have been conducted with percentages of broadband users that take superfast broadband set to 80% (allows higher take-up for FTTC) and 50% (lower take-up of FTTC).

The base case also assumes that over time BTOR would seek to match the coverage of Docsis resulting in 95% FTTC coverage in areas where DOCSIS is available by 2014. Alternative penetration forecasts with a reduced FTTC coverage in DOCSIS areas (72%) were done for the base case and the case with higher conversion to superfast broadband (see figure 5-1). This increases the number of FTTC subscribers compared to the original cases.

Figure 5-1: Number of subscribers under different penetration profiles in the cost model (year end figures)



Since most of the investment is defined by coverage, the penetration is a very direct impact factor for the monthly cost per line. The following table shows the impact of the described stand-alone penetration sensitivities, i.e. keeping all other parameters at the base case level. A decrease of up to £0.78 and an increase by up to £0.91 can be observed.

Table 5-2: Impact of different penetration profiles on the monthly cost per line

	monthly cost per line (£)	change to base case(£)	change to base case in %
Base Case	4.39		
50% of BTOR BB customers in passed areas on NGA	5.29	0.91	21%
80% of BTOR BB customers in passed areas on NGA	3.78	-0.61	-14%
65% of BTOR BB customers in passed areas on NGA - FTTC coverage of DOCSIS footprint only reaches 72%	4.13	-0.26	-6%
80% of BTOR BB customers in passed areas on NGA - FTTC coverage of DOCSIS footprint only reaches 72%	3.61	-0.78	-18%

Clearly, the extent to which available ducts can be reused directly impacts on the investment and cost for the feeder segment. The following table shows two stand-alone sensitivities for 50% and 80% duct reuse.[63] The results confirm the expectations on the impact of this cost driver. As can be seen in the results the chosen reduction in duct reuse is twice as big as the increase and leads to twice as large a change from the base case. It should be noted however, that assuming lower duct re-use results would result in total investment significantly higher than the £2.5bln reported by BT.

Table 5-3: Impact of duct reuse on investment and monthly cost per line

	simple sum of initial investment without renewals (£bn, real terms)	per passed home (£, real terms)	monthly cost per line (£, nominal)	change to base case (£)	change to base case in %
Base Case	2.25	110	4.39		
duct reuse share lowered from 70% to 50%	3.10	151	5.61	1.22	28%
duct reuse share raised from 70% to 80%	1.83	89	3.7	-0.61	-14%

63 Based on available information from BT duct surveys 80% could be considered the maximum conceivable degree of duct reuse.

Regarding the WACC five stand-alone sensitivities were carried out. In the first sensitivity the new ducts were also deemed eligible for a risk premium. [64] In further sensitivities the risk premium was lowered from 2% to 0%, effectively levelling the WACC for all assets at the baseline level of 8.8%. Conversely, another sensitivity increased the risk premium from 2% to 4%. Lastly, the risk premium was kept at 2% but the baseline level was changed to 7% and 10%.

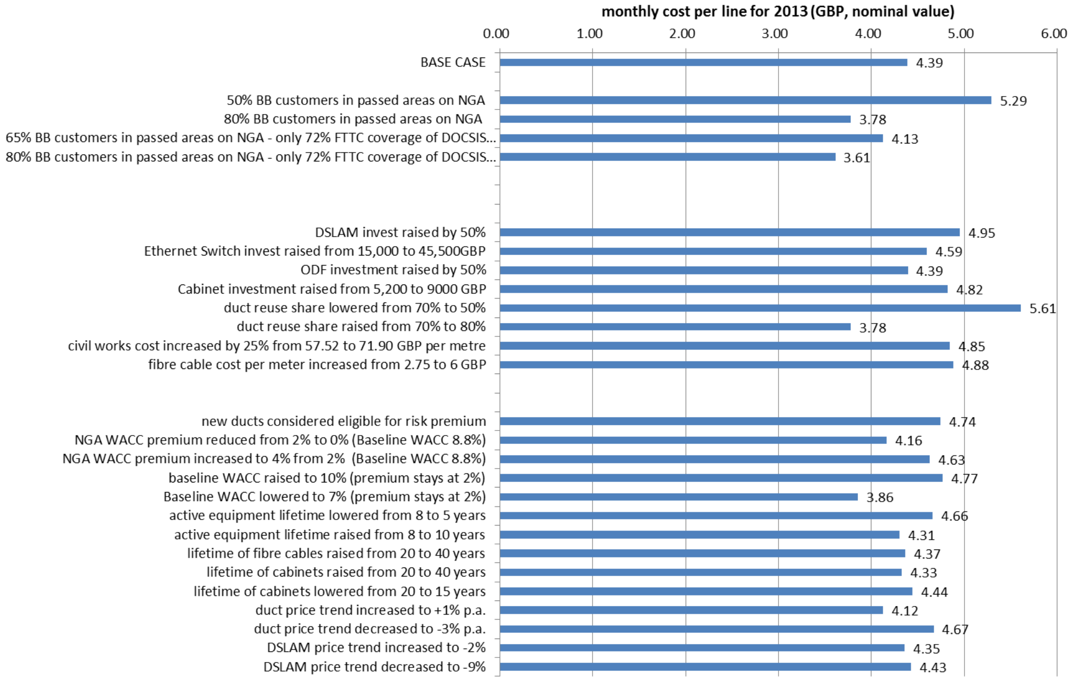
Table 5-4: WACC sensitivities

	monthly cost per line (£, nominal)	change to base case (£)	change to base case in %
new ducts considered eligible for risk premium	4.74	0.35	8%
NGA WACC premium reduced from 2% to 0% (Baseline WACC 8.8%)	4.16	-0.23	-5%
NGA WACC premium increased to 4% from 2% (Baseline WACC 8.8%)	4.63	0.24	5%
baseline WACC raised to 10% (premium stays at 2%)	4.77	0.38	9%
Baseline WACC lowered to 7% (premium stays at 2%)	3.86	-0.53	-12%

Many more sensitivities were conducted and they are summarized together with the stand-alone runs already discussed above in the following diagram. This indicates a range between £4 and £5.50 for monthly GEA cost per line.

64 An alternative approach towards the WACC and the treatment of ducts could be to set the premium to 1% and apply it also to ducts. This would acknowledge a certain FTTC specific risk but make the reduction sharper compared to risk levels of FTTH. This would yield a result of £4.45 per month.

Figure 5-2: Overview of stand-alone sensitivities



5.2 Comparison of results with Openreach price list

In constructing the cost model we found that there are practically no bandwidth driven cost components so a uniform price per GEA line was reported. In contrast, Openreach GEA pricing is differentiated according to downstream / upstream bandwidth combinations. Table 5-5 shows monthly pricing for products below 100Mbps downstream, i.e. in the relevant bandwidth range for FTTC. The price lies between £7.40 and £9.95 per month. [65]

Table 5-5: Openreach GEA pricing below 100Mbps valid from April 1st 2013

Product combinations (downstream / upstream)	Annual charge (£)	Monthly charge (£)
40 Mbps / 10 Mbps	88.80	7.40
40 Mbps / 15 Mbps 80Mbps / 20 Mbps	119.40	9.95

Source: Openreach website

65 At the time of writing Openreach was also offering a 40Mbps downstream / 2 Mbps upstream product for £6.90 which was about to be withdrawn.

6 Review of comparable international wholesale prices

6.1 Overview of countries for benchmarking

The objective of this benchmark exercise is to provide insights on the price level of NGA wholesale products in other countries where charges have been regulated on the basis of cost-orientation. In selecting suitable comparisons, it was necessary to consider the technologies used as well as the handover point. The closest comparable wholesale product to Openreach's FTTC GEA is a VDSL bitstream with handover at the exchange, available in Belgium.

In order to obtain a broader base for comparison point to point fibre unbundling products in the Netherlands and Sweden were analysed on the expectation that, whilst not directly comparable to the GEA FTTC product, they are available at similar handover points, offer even more bandwidth and quality and thus GEA should be no more costly. This is because GEA (on the basis of FTTC) only reflects new fibre installation between the cabinet and the exchange and implies the re-use of existing copper assets in at least the subloop.

Therefore, the following countries and wholesale products were selected for this benchmarking exercise[66]:

- Belgium (VDSL bitstream at the exchange)
- Netherlands (fibre unbundling)
- Sweden (fibre unbundling)

6.2 Summary of findings

There are a variety of products and tariff structures in the countries considered. In contrast to the UK, in Belgium the price per line is flat and includes a fixed transport component. In the Netherlands there are different charges depending on the exchange area. For comparison with other countries we use the national average over all exchange areas.

As a benchmark point for UK we consider the 40 Mbps downstream/10 Mbps upstream GEA product in cases where the comparator countries rely on FTTC. We use the 80 Mbps downstream/20Mbps upstream GEA product as a benchmark when comparing with countries offering FTTH/B unbundling. The monthly charge for copper LLU in UK

66 France was not included into the benchmark as fibre unbundling is so far not imposed on the incumbent operator France Telecom (Orange). Instead, there exist a symmetrical obligation for all operators to provide access to the terminating segment, including access to wiring inside buildings. With regard to bitstream products, currently there is only ADSL WBA offered by France Telecom. Nevertheless, VDSL field trials have already started and provision of a NGA bitstream product is expected in near future.

(£7.10) was added to the GEA charge because either copper LLU or WLR must be purchased by operators in addition to GEA. Prices should therefore be compared on a total cost basis. Table 6-1 summarises the charges for FTTC products in UK and Belgium. The cost-based charge in Belgium is lower than the one charged by Openreach for its 40 Mbps/10 Mbps product.

Table 6-1: Overview of NGA wholesale prices (VDSL-based products)

Country	NGA wholesale product	Prices set cost oriented?	Monthly charge for NGA wholesale product)[67]	Comment
UK	**VULA (GEA) 40 Mbps**	**No**	**£14.5** [68] **(£7.1 copper LLU + £7.4 GEA)**	**LLU charge + GEA product (40 Mbps downstream; 10 Mbps upstream)**
Belgium	VDSL bitsream at the exchange	Yes (BU-LRAIC)	£12.30 (14.25 €)	incl. transport rental for dedicated VLAN

When comparing FTTH products with the 80 Mbps downstream/20 Mbps upstream GEA product, Sweden has the lowest charge, followed by the Netherlands.

Table 6-2: Overview of NGA wholesale prices (FTTH/higher speed products)

Country	NGA wholesale product	Prices set cost oriented?	Monthly charge for NGA wholesale product)[69]	Comment
UK	**VULA (GEA) 80 Mbps**	**No**	**£17.04** [70] **(£7.1 copper LLU + £9.95 GEA)**	**LLU charge + GEA product (80 Mbps downstream; 20 Mbps upstream)**
Netherlands	fibre ULL	Yes (DCF model, but prices set below the regulated cap)	£14.10 (16.39 €)	average charge over all exchange areas
Sweden	fibre ULL	Yes (hybrid LRIC)	£12.80 (128 SEK)	Fiber Villa product

Whilst charges for GEA appear higher than those in benchmark countries in which charges have been set on the basis of cost-orientation, it should be noted, that charges across countries are not necessarily directly comparable due to national specificities as well as product differences. The countries differ with regard to settlement structure and number of exchanges and cabinets, feeder and subloop length and their price determination methods. Moreover, parameters like WACC and cost for civil engineering are

67 Exchange rate used: 1 € = £0.86, 1 SEK = £0.1 from 27.02.2013
68 Charges valid from 01.04.2013
69 Exchange rate used: 1 € = £0.86, 1 SEK = £0.1 from 27.02.2013
70 Charges valid from 01.04.2013

country-specific and have a strong impact on wholesale prices. Therefore, there are limits of comparability.

The next two sections provide a brief description of relevant products in the benchmark countries and corresponding price information.

6.3 VDSL bitstream at the exchange

6.3.1 Belgium

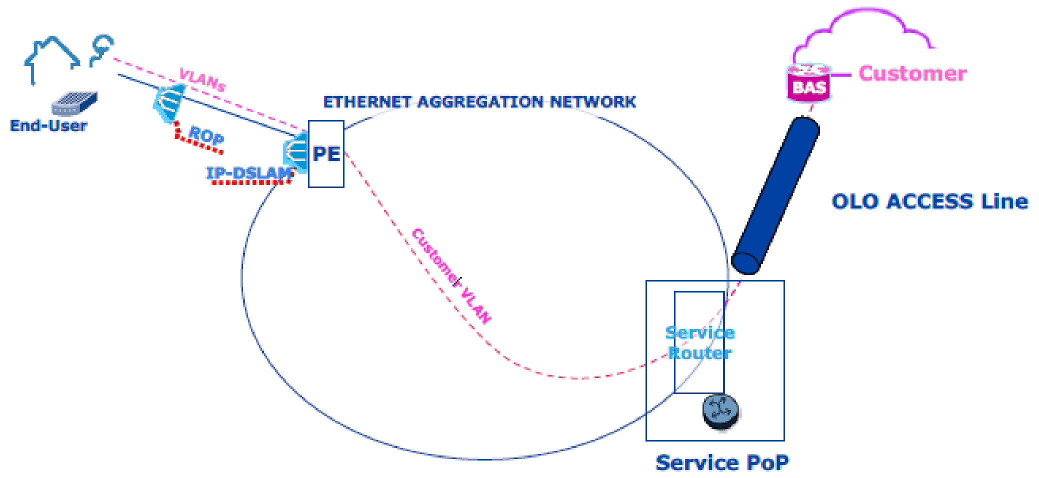
The most recent WBA VDSL2 offer of Belgacom (the Belgian incumbent telecoms provider) was published in November 2012[71]. It allows for traffic handover at different levels (local and regional), flexible allocation of VLANs, the ability to differentiate quality of service levels, service speeds and service symmetry.

The reference offer includes following components (see Figure 6-1):

- the provision by Belgacom of VDSL2 access lines between the DSLAM and the end user;
- the provision and the configuration by Belgacom of Ethernet transport between the IP-DSLAMs and the access seeker equipment;
- the provision of bandwidth (VLANs) between the IP-DSLAMs and Belgacom Service PoPs to which the alternative operators are connected; these VLANs can be either shared between several users in the same exchange area or dedicated per separate user;
- the provision of one or several access lines between the access seeker's premises and the Belgacom Service PoPs (OLO Access Line);

71 Belgacom's reference offer is available at http://www.belgacomwholesale.be/wholesale/en/jsp/dynamic/product.jsp?dcrName=nws_wba_vdsl2

Figure 6-1: Overview of Belgacom's WBA VDSL2 product



Source: Belgacom

In the following we only focus on Belgacom's bitstream access product with handover at the exchange as this is the most comparable product with GEA in the UK. Therefore we provide an overview of the charges for provision of VDSL access line and connection between the DSLAM and the Ethernet switch of the access seeker at the exchange.

The total monthly rental fee per line consists of the sub-loop tariff (5.94 €), active and passive element cost and transport cost (see Table 6-3). There is no separate charge per Mbps for transport from DSLAM to the exchange, the fix rental fee per line already covers the local part of the transport. The transport rental however depends on whether shared or dedicated VLAN is concerned. The cost of handover port is already included in the rental fee of the VDSL line.

The activation fee amounts to 72.59 €/line for shared VLAN, respectively 157.99 €/line for dedicated VLAN.

Table 6-3: Monthly recurring fee per line (stand alone product)

	shared VLAN	dedicated VLAN
Sub-loop charge	5.94 € (£5.11)	5.94 € (£5.11)
Passive part	4.46 € (£3.84)	4.46 € (£3.84)
Active part	3.07 € (£2.64)	3.07 € (£2.64)
Transport rental ETH	0.62 € (£0.53)	0.78 € (£0.67)
Total monthly rental	**14.09 € (£12.12)**	**14.25 € (£12.26)**

The charges above have been determined by the Belgian regulator BIPT applying a bottom-up LRAIC model. Currently BIPT is in process of developing a new cost model. The present rental charge for Ethernet transport does not apply for very high bandwidth, therefore new prices per Mbps will be defined.

6.4 Other comparable products

As mentioned before we consider as alternative benchmark points FTTP wholesale products. There are only a few regulated or publicly known prices for FTTP wholesale products (unbundled fibre), such as in the Netherlands and Sweden.

6.4.1 Netherlands

In the following we outline the fibre unbundling product in the Netherlands called ODF unbundling.

In the Netherlands unbundled access to the copper loop is offered by KPN (the incumbent) whereas unbundled access to the fibre loop is offered by Reggefiber (a joint venture of KPN and Reggeborgh). Therefore the two types of unbundled access are not included in the same reference offer.

FTTP access prices in the Netherlands are geographically differentiated and depend on the actual CAPEX per line in an exchange area. Depending on the characteristics of the area (dense or rural) a different tariff applies. OPTA has set a price cap for ODF unbundling for each CAPEX class in the range of 15.52 € - 25.99 € per month and line.[72] The operator however decided to price below the cap as Table 6-4 shows[73].

72 Price caps are updated annually by OPTA.
73 See also Reggefiber's reference offer available at http://www.eindelijkglasvezel.nl/odf.html

Table 6-4: ODF unbundling monthly charges per CAPEX class (excl. VAT)

CAPEX class	Exchange area	Price cap set by OPTA for monthly charge	Monthly charge (charged by Reggefiber)
I	775-825	15.52 € (13.35 £)	15.52 € (13.35 £)
II	825-875	16.33 € (14.04 £)	16.06 € (13.81 £)
III	875-925	17.13 € (14.73 £)	16.06 € (13.81 £)
IV	925-975	17.94 € (15.43 £)	16.06 € (13.81 £)
V	975-1025	18.74 € (16.12 £)	16.06 € (13.81 £)
VI	1025-1075	19.54 € (16.80 £)	16.87 € (14.51 £)
VII	1075-1125	20.35 € (17.50 £)	17.67 € (15.20 £)
VIII	1125-1175	21.16 € (18.20 £)	17.67 € (15.20 £)
IX	1175-1225	21.96 € (18.89 £)	17.67 € (15.20 £)
X	1225-1275	22.77 € (19.58 £)	17.67 € (15.20 £)
XI	1275-1325	23.57 € (20.27 £)	17.67 € (15.20 £)
XII	1325-1375	24.38 € (20.97 £)	17.67 € (15.20 £)
XIII	1375-1425	25.19 € (21.66 £)	17.67 € (15.20 £)
XIV	1425-1475	25.99 € (22.35 £)	17.67 € (15.20 £)
National average		**18.84 € (16.20 £)**	**16.39 € (14.10 £)**

Source: Reggefiber's reference offer, Annex Prices, p. 5

The average monthly charge over all exchange areas amounts to 16.39 € per line. The connection charge is set at 107.08 €.

6.4.2 Sweden

In Sweden there is a variety of fibre unbundling products (FTTH/B) offered by Skanova, a subsidiary of the incumbent TeliaSonera.

The connection charge depends on whether fibre is already existing and the type of technical work required. For FTTP connection to a detached house the one-off charge amounts to 505 SEK.[74] The monthly rental charge for the same product is 128 SEK per line. The prices are set by the regulator PTS using a hybrid LRIC model which is reviewed every three years and is updated each year with new market data. The charges for fibre LLU are therefore set annually.

The LRIC hybrid model only uses fibre access technology to calculate the costs for both copper and fibre based wholesale access services.

74 See reference offer for Fiber Villa product: https://www.skanova.se/SKAWEB/Produkterochnat/Dokumentation/index.htm?productName=Fiber%20Villa