Business Connectivity Market Review

Review of Network Reach and Service Share models

March 2013

ERNST & YOUNG

Quality In Everything We Do

Disclaimer notice

Ernst & Young LLP
1 More London Place
London SE1 2AF

Tel: 020 7951 2000
Fax: 020 7951 1345
www.ey.com/uk

Reliance Restricted
The Office of Communications (Ofcom)   25 March 2013
Riverside House
2a Southward Bridge Road
London
SE1 9HA

Dear Sirs

Business Connectivity Market Review

In accordance with the Master Service Agreement 2009 between Ernst & Young and The Office of Communications, and the Service Requirements Letter number 945 dated 2 January 2013 (including the addendum letter dated 15 March 2013), we planned and performed a set of test procedures, using reasonable skill and care, in the context of your requirements, of certain business models (the "**Models**", as defined below). The scope and limitations to the scope of our work are set out below.

Introduction

Ofcom is currently undertaking a formal assessment of the state of competition in the provision of leased line services in the UK (the Business Connectivity Market Review, "BCMR"). In June 2012 Ofcom published a consultation setting out the provisional findings of this review. In the consultation Ofcom proposed that BT and KCOM have Significant Market Power (SMP) in a number of economic markets. As a result Ofcom proposed that BT and KCOM should be subject to a range of obligations designed to promote competition, for example obligations to supply wholesale services at regulated charges.

Two pieces of data analysis involving large datasets were important inputs to Ofcom's proposed market definitions and SMP findings:

► **Network Reach analysis** – an assessment of the potential for infrastructure based competition based on the proximity of UK businesses to communications provider's networks, and

► **Wholesale Service Share analysis** – an assessment of the proportion of leased lines provided by each operator in each of the product markets Ofcom defined.

Ofcom is looking for an independent review of the models used to support this analysis (the "**Analysis**").

The Analysis

(1) Network Reach analysis

The Network Reach analysis undertaken by Ofcom has three stages:

► The input datasets are processed in Microsoft Access using a series of queries. The operations include selecting the sub-set of business sites and associating postcodes with geographic coordinates

► A command prompt program written in C is used to perform a large series of triangulation calculations on the OS Easting / Northing map coordinates to calculate the proximity of Communication Providers ("**CP**s") flexibility points to business sites.

► An Excel model is used to produce the outputs by postcode sector.

The Network Reach analysis process can be understood by the following flow diagram. The white boxes at the bottom depicting the raw data files are outside the scope of this review.
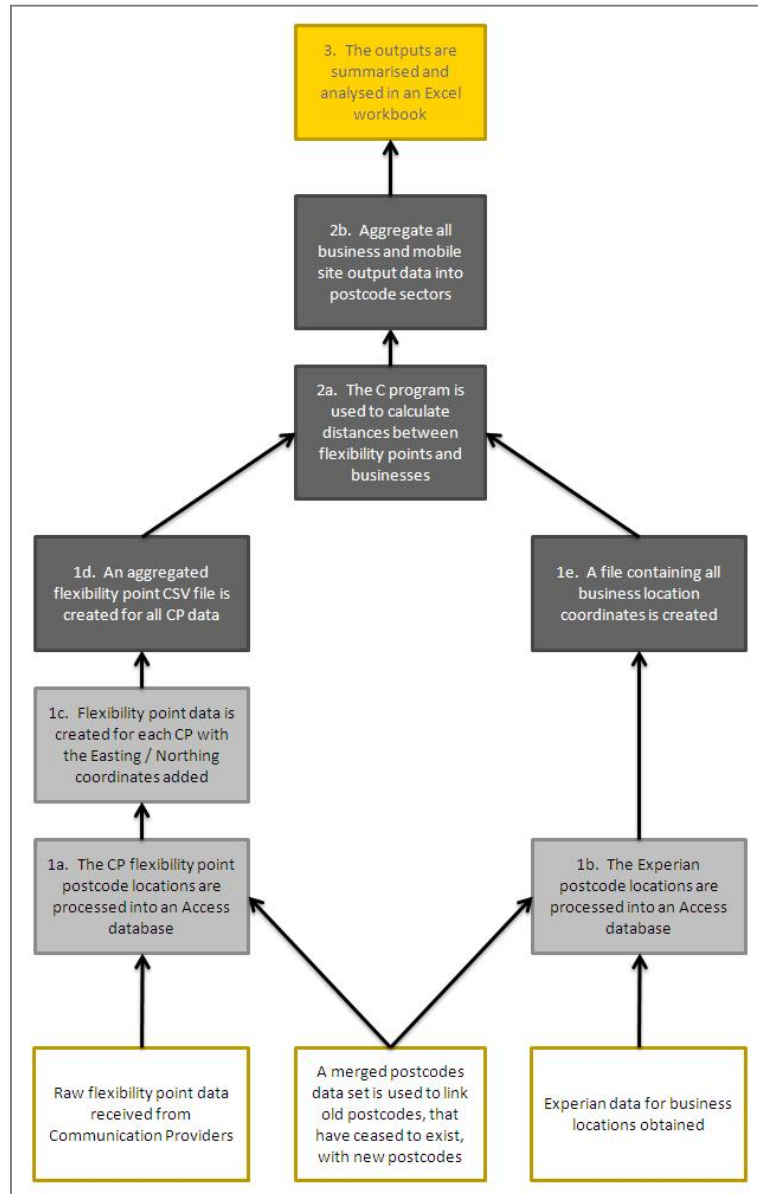
(2) Wholesale Service Share analysis

The Wholesale Service Share analysis undertaken by Ofcom has two parts:

► The input datasets supplied by operators are processed in Microsoft Access in accordance with a set of cleaning guidelines that translates the data into a common format for further analysis.

► The cleaned data is then processed in the Excel-based Wholesale Service Share model which calculates wholesale service shares according to a variety of different assumptions in each of the defined markets.

The Excel model comprises approximately 20 tabs, about half of which perform calculations. The model uses a Visual Basic macro to count the number of circuit ends supplied by each CP in each of the 10043 postcode sectors meeting the relevant bandwidth and technology criteria. This calculation is performed for each input dataset (retail, wholesale provision, wholesale purchase) and the macro pastes the results of the count of circuit ends into separate tabs. Using these outputs Ofcom estimates each CP's wholesale service supply volume per postcode sector as its sales (retail plus wholesale provisions) less its purchases. The model also incorporates an adjustment to account for circuits with partially incomplete information (either bandwidth or location).

The Service Share analysis process can be understood by the following flow diagram. The white boxes at the bottom depicting the raw data files are outside the scope of this review.
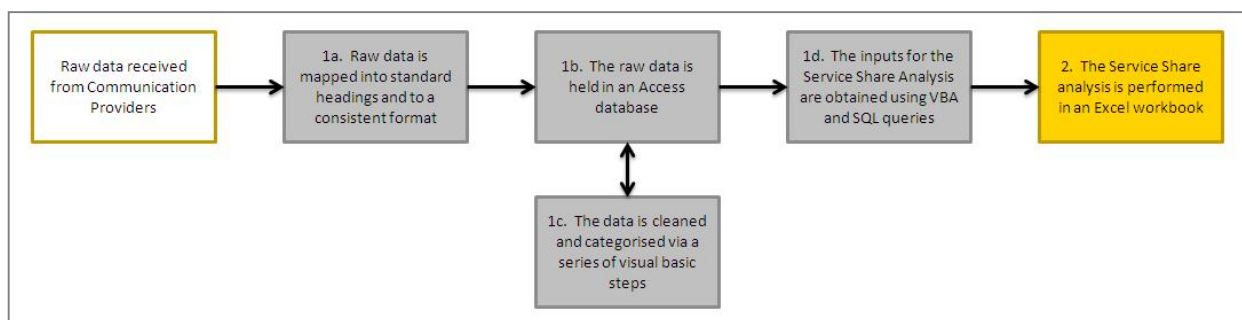

Scope of work

The models considered as part of this work are listed in appendix A, and within this letter, the models listed below are collectively referred to as the "**Models**". Each file was developed by Ofcom.

You have asked us to undertake certain agreed procedures (the "**Procedures**") in relation to the Models to assist you in determining whether the Models have been constructed appropriately, in so far as their logical integrity and arithmetic is concerned. You asked us to perform the procedures as outlined below.

1. Testing the logical construction of analysis performed in Excel by reference to their formula in order to test their logical integrity and arithmetical accuracy.

2. Testing the construction and operation of analysis performed by Visual Basic programming in order to tests its logical integrity and completeness of data processing.

3. Testing the logical construction of analysis performed in Access queries by reference to their design and construction in order to test their logical integrity and completeness of data processing.

4. Testing the logical construction and operation of analysis performed by the C program in order to test its logical integrity and completeness of data processing.

Our approach

We performed certain procedures on the Models, as outlined above, and detailed in the tables below. At a high level this involved:

a) Re-performing, where possible the processing, performed by Ofcom's analysis in order to obtain consistent results, and testing the completeness of the data processing performed so that the number of output records matched the number of input records as appropriate.

b) Any errors identified or clarifications required were presented to you for your comment. Where changes were required to be made to the models, these were made by you and then re-

reviewed by us to confirm that the change had been made in accordance with our original finding where appropriate.

c) We reviewed any explanations provided by you to our queries to assess their reasonableness based upon our understanding of the Models' operations and significance to the overall outcomes.

Limitations to the scope of our work

Our scope of work in relation to the Models was limited to the review procedures outlined above. Our review was limited as follows:

i) We have not been required to express any opinion on the validity of the assumptions nor on any commercial risks associated with the project.

ii) We have not made any recommendations to Ofcom, nor have we advocated a particular approach, methodology or strategy that Ofcom should follow.

iii) We have not considered comments included in cell notes embedded in the Models, to ensure that they are consistent with the Models.

iv) Our review considered only the contents of the Models as presented to us.

v) Our review focused only on those Models listed in appendix A. We undertook our work on the Models as they are presented to us for review. Should subsequent updates to data or logic occur in any of the Models after our review concluded then we have not been instructed by you, nor have we attempted to update our test procedures in lieu of these changes.

vi) In performing our review, we have taken account of explanations and information provided to us by Ofcom in relation to the intended operation of the Models.

vii) Base case and sensitivity cases

The Models' base case shall be the input configuration of the Models in the form in which they are provided to us, subject to the operation of macros or other automated adjustments required for the Models' operation. A sensitivity case is a variation to the base case input configuration.

viii) Software defects and known model defects

We will look at the contents of the Model in the file format in which it is provided to us. However, we will not carry out any enquiry into, or review of, the software within which the Model operates (such as, for example, Microsoft Excel). Accordingly, we shall have no responsibility for the consequences of any inherent defect in such computer software programs.

You will inform us on a timely basis of all significant Model defects which you are aware of when we commence our work, or which you subsequently become aware of during the course of our review.

ix) Use of the term 'audit'

The review of a business model differs significantly to the statutory audit of financial statements; for example, the extent to which corroboratory evidence is sought and the applicability of auditing standards and company law. Where our review is referred to as an 'audit', we accept no additional responsibilities which may be implied by a comparison to the statutory audit of financial statements.

Procedures

The tables below show the review procedures undertaken for both the Network Reach analysis and the Service Share analysis.

(1) Network Reach analysis

Ofcom analysis	Test procedures undertaken	File
Communication Provider's raw flexibility point data: ► Data is received from the Communication Providers (CPs) listing the postcodes and Easting and Northing coordinates for their flexibility points. ► This data is compared against postcode data for previous years to ensure consistency of locations where postcodes have changed over time. ► The postcodes are then mapped to Easting and Northing coordinates (if not already provided) ► The process is repeated for large business sites, mobile network sites, local exchanges and data centres. ► Flexibility points without a corresponding valid Easting / Northing coordinate are removed from the data set.	► For a selection of CPs (see file references for details), we verified whether the raw data input files were processed appropriately and included within the output file[1]. ► We reviewed the logic of the data processing queries in the Access database and re-performed these queries to obtain consistent results. ► We performed this by reviewing the processing steps performed for the sample chosen, and confirming that all of the data was processed and included within the output file as appropriate.	Files 1, 5 - 14
Experian business location data set: ► Data is obtained from Experian containing postcode data for all UK businesses. ► These postcodes are compared against postcode data for previous years to ensure consistency of locations where postcodes have changed over time. ► The postcodes are mapped to their Easting / Northing coordinates similarly to the flexibility points data above. ► Only businesses with 250 employees and above are selected for this analysis.	► We reviewed the logic of the data processing queries in the Access database (File 16) and re-performed these queries to obtain consistent results. ► We reviewed the data to look for duplicate entries. ► We tested that only business with over 250 and above employees had been selected. ► We traced the data within the database back to the source inputs files to test for completeness.	Files 15 – 18
BT local exchange location data set: ► Raw data for local exchange locations are converted into Easting / Northing coordinates file. This is a preparation step only as no matching against previous postcodes is required as Easting / Northing coordinates are contained in the raw dataset	► We confirmed that the local exchange output file agreed back to the raw data file	Files 19 – 22

---

[1] The processing of the data files was outside the scope of our review, but these steps were performed on a limited basis to see whether the raw data was being appropriately treated by Ofcom and whether further investigation would be of benefit to Ofcom.

Ofcom analysis	Test procedures undertaken	File
Mobile operators site location dataset: ► The raw data files are consolidated into a single data list with postcodes and Easting / Northing coordinates ► This data is compared against postcode data for previous years to ensure consistency of locations where postcodes have changed over time. ► Where the mobile network operator did not provide Easting / Northing coordinates, the coordinates for the geometric centre of the corresponding postcode were used instead. ► The final data set is created combining the updating Easting / Northing data against any original Easting / Northing coordinates provided.	► We matched the consolidated data set by reference to the original raw data files. ► We inspected the logic of the data processing queries in the Access database (File 25) and re-performed these queries to obtain consistent results. ► We confirmed that the output file was a combination of the Access database outputs and the raw data files.	Files 23 - 28
C program for calculating distances: ► A C program was written by Ofcom to calculate the number of CPs within a given distance of a user location. ► The program uses the consolidated list of flexibility points and the list of either the business sites, or the mobile network sites, or the local exchanges, or the data centres, depending on the analysis being performed. ► The output of the program is a CSV file containing the number of flexibility points within a certain number of meters away, split by CP and postcode.	► We reviewed the logic of the program and noted any inconsistencies and items of best practice. ► We tested the outputs of the C program by building a parallel process using Microsoft Access. We performed this on the business network data only. ► We compared the outputs of our parallel build with the outputs of the C program to test for consistency.	Files 1 - 4, 15, 29 - 30
Network Reach summary files: ► The output of the C program is first aggregated into postcode sectors and then entered into a summary file, where the results are presented and analysed. ► There are 4 outputs files (files 1 to 4) – one for each dataset type.	► We tested the output files by reference to their formulae to assess their logical integrity and arithmetical accuracy. ► We also tested the output files by comparing them with each other to look for consistency of approach adopted for each data set.	Files 1 - 4.

(2) Service Share analysis

Ofcom analysis	Test procedures undertaken	File
Process raw data files: ► The raw data received from the CPs needs to be mapped into a consistent format so that the analysis can be performed. ► An Excel file (file 6) containing VBA is used to map the data into the consistent headings, and the outputs are held in an Access database (file 4)	► We reviewed the VBA in file 6 to test its logical flow and for best practice. ► We created a blank database, and re-ran the VBA to recreate the analysis process. We compared the outputs for a selection of raw data files (files 1 to 3)[2]. ► We checked that the data from the selection of raw data files were imported into the correct data columns, and also that the full set of data was imported in each case.	Files 1 – 4, 6

---

[2] The processing of the data files was outside the scope of our review, but these steps were performed on a limited basis to see whether the raw data was being appropriately treated by Ofcom and whether further investigation would be of benefit to Ofcom.

Ofcom analysis	Test procedures undertaken	File
Clean the raw data: ► A series of automated steps are performed on the raw data sets imported to clean the data to be fit for the analysis and to add new category information. ► An Excel file (file 7) containing VBA runs several queries on the raw data in file 4 to add additional categories to the information sets, and to clean the data where relevant. ► There are 20 steps performed as part of this process to prepare the data ready for the analysis.	► For each of the queries defined in File 7 we reviewed the VBA to test its logical flow and for best practice. ► We transferred the query designs into a test database so that the query design could be reviewed directly. We tested whether the outputs of the query matched those in File 4. ► Where data flowed backwards and forwards between the Excel file and the Access database, we tested to see that the complete data set was transferred on each occasion. ► Where possible, we looked at whether manual category inputs had been consistently applied across the full data set so that the same types of circuits were categorised in similar ways.	Files 4 and 7
Export results to Excel: ► Any data items that contain two data points are also split into separate records. ► The relevant data for the analysis in the access database (file 4) is collated and exported into three datasets: Wholesale, Purchased and Retail networks.	► We tested whether the additional lines were being created appropriately. ► We tested whether the appropriate data was being selected from the database, and that the complete data set was being exported. ► We tested whether the data was appropriately split between Retail, Wholesale and Purchased.	Files 4 and 5
Perform the Wholesale Service Share analysis: ► An excel file (file 8) is used to perform the final Service Share analysis on the data sets exported from the Access database. The spreadsheet allows the data to be analysed according to different market definitions.	► We tested the Wholesale Service Share model by reference to its formulae to assess its logical integrity and arithmetical accuracy. ► We tested the VBA used in the Wholesale Service Share model to test its logical integrity and noted any inconsistencies and items of best practice. ► We tested the outputs created by the VBA by using pivot tables and other techniques to validate the results.	File 8

Findings and conclusion

Network Reach - findings

	findings	findings resolved*	findings outstanding	
Issues found requiring a change to a model	1	1	0	*Resolved findings are those that were discussed and explained by Ofcom or where the model was corrected in response to the finding
Other queries and findings raised	23	23	0	
Total	**24**	**24**	**0**	

Service Share analysis – findings

	findings	findings resolved*	findings outstanding	
Issues found requiring a change to a model	14	14	0	*Resolved findings are those that were discussed and explained by Ofcom or where the model was corrected in response to the finding
Other queries and findings raised	25	25	0	
Total	**39**	**39**	**0**	

Based on the review procedures shown above, we are not aware of any matters which came to our attention in the course of our review to indicate that the Models have not been constructed appropriately, in so far as their logical integrity and arithmetic are concerned, so as to materially achieve the objectives described above under the base case assumptions.

Yours faithfully

Ernst & Young LLP

Ernst & Young LLP

Appendix A - Files

Network Reach files

	Name of file reviewed	Date of file	Size of file (kb)
1	[●]	20/12/2012	18,342
2	[●]	11/12/2012	260
3	[●]	20/12/2012	7,781
4	[●]	19/12/2012	6,860
5	[●]	22/1/2013	335
6	[●]	23/1/2013	416
7	[●]	20/11/2012	36
8	[●]	25/1/2013	22
9	[●]	4/10/2011	331
10	[●]	8/7/2011	1,922
11	[●]	13/11/2012	29
12	[●]	12/11/2012	168
13	[●]	5/12/2012	183
14	[●]	23/1/2013	341,252
15	[●]	16/11/2012	4,685
16	[●]	23/1/2013	915,984
17	[●]	14/11/2012	4,419
18	[●]	12/11/2012	474,339
19	[●]	16/11/2012	5,825
20	[●]	1/7/2011	705
21	[●]	15/11/2012	613
22	[●]	25/11/2012	399
23	[●]	15/11/2012	2,647
24	[●]	22/1/2013	1,246
25	[●]	25/1/2013	736
26	[●]	15/11/2012	21,653
27	[●]	15/11/2012	1,364
28	[●]	16/11/2012	2,545
29	[●]	4/12/2012	7
30	[●]	20/11/2012	5,577

Service Share files

	Name of file reviewed	Date of file	Size of file (kb)
1	[●]	1/11/2011	4,913
2	[●]	9/1/2013	35,972
3	[●]	9/1/2013	7,071
4	[●]	10/12/2012	1,088,592
5	[●]	10/12/2012	40
6	[●]	11/12/2012	75
7	[●]	10/12/2012	1,645
8	[●]	7/1/2013	156,897