Study of Geographic Telephone Number Demand

REPORT TO OFCOM

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STUDY OF GEOGRAPHIC TELEPHONE NUMBER DEMAND

1 SUMMARY OF FINDINGS

1. The number of exchange lines is diminishing relatively quickly but it is too early to determine whether this is affecting demand for number blocks.

2. The number of households is rising, in most areas but this may not lead to an overall increase in geographic numbers used as a consequence of the reduction in numbers of exchange lines. Only 17 area codes are likely to have an increase in the number of lines in use.

3. Requirements for personal geographic numbering may have a significant impact particularly within area codes servicing university towns.

4. The number of Providers seeking number blocks has expanded and is continuing to expand rapidly with the introduction of VoIP over broadband, which relaxes geographic constraints on service provision.

5. No region is particularly disadvantaged with respect to broadband supply.

6. In any given year, the number of Providers with number blocks in an area is proportionate to the numbers in use in that area. Providers prioritise areas by population or by numbers in use.

7. Demand for numbers in any area is growing from year to year. The rate of growth is increasing, but it is likely to reach a ceiling.

8. Providers are constraining the number of blocks that they are requesting but in many cases are likely to continue to request blocks on a phased basis until they can provide numbers in all areas.

9. Traditional Providers including NTL, Telewest and BT have multiple block allocations covering the area codes that they serve. New Providers typically have only one block in an area. With increasing demand for services, these new Providers may require additional blocks.

10. We concluded that scenario based modelling was most appropriate using a Monte Carlo simulation technique was most appropriate given the level of uncertainty in a number of the parameters that drive the model.

11. We concluded that the number of area codes suffering exhaustion at a given level of probability will increase through time based on the Monte Carlo simulation as shown in Figure 1.

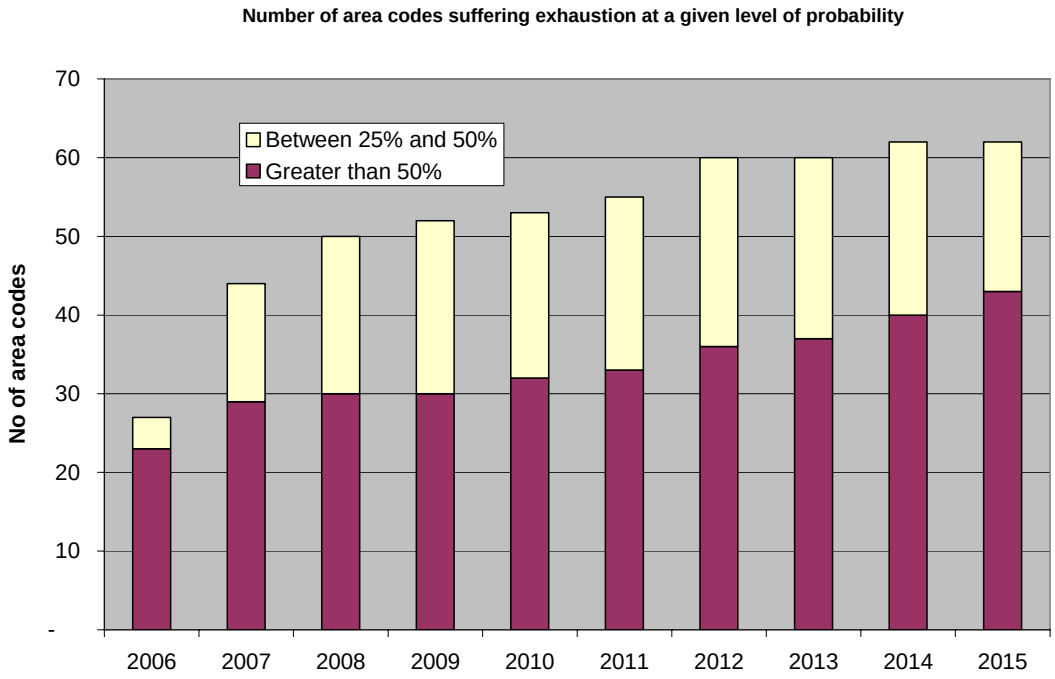

Figure 1: Number of area codes suffering exhaustion

2 BACKGROUND TO ANALYSIS

2.1 Background

Ofcom is responsible for administering the UK's National Telephone Numbering Plan ('the Plan') (which sets out Telephone Numbers available for allocation and any restrictions in their use) and the Numbering Scheme (the day-to-day record of numbers allocated in the UK). Ofcom must also comply with its general duties under the Communications Act 2003 (the Act) to promote competition and the interests of citizen-consumers. In exercising these functions, Ofcom has a duty to secure what appears to them to be the best use made of telephone numbers and to encourage efficiency and innovation for that purpose, thus ensuring sufficient and appropriate telephone numbers are available to provide communications services to consumers. This includes the need to ensure that sufficient numbers are available in each Geographic Area Code to meet Communications Providers' needs.

Ofcom commissioned research from Intercai Mondiale as part of a wider numbering strategy project. Ofcom's key objective was to get a more detailed understanding of the demand trend for geographic telephone numbers over the next ten years. The use of these numbers is not restricted to any particular service type and should include geographic telephone numbers used for the delivery of VoIP services.

The study was intended to clearly identify the drivers for growth in the demand for numbers and the predicted impact of these drivers. It is expected that these drivers will include an increase in the number of electronic communication network/service Providers along with, but not limited to changes in demographics (e.g. including regional development plans) and consumer behaviour factors. The study was intended to cover, but not be limited to the following factors:

- Changes in total network/service Provider demand for numbers, including:
  - The growth in the number of network/service Providers
  - How many numbers will be required by each network/service Provider
- Changes in end-user demand
- What drives the changes in demand for geographic numbers
- Identification of notable regional or local differences in demand, for example, influenced by new build developments in particular areas.
- Identification of notable variations in growth within the year on year trends

The study was not intended to make any assumptions about any changes in the mechanisms for the supply of geographic telephone numbers, such as the implementation of dialling code changes or reclamation of substantially unused number blocks.

The delivered report was expected to state all sources, assumptions and give details of the modelling methods used to arrive at demand projections.

2.2 Project Deliverables

The deliverables of this project are:

a) A kick-off meeting to discuss the scope of the project and the proposed approach to be followed;

b) a written report which should be provided in both hard and softcopy (Microsoft Word format);

c) a presentation and discussion with Ofcom after delivery of the first draft of the report;

d) a final version of the report modified to take account of Ofcom's comments.

2.3 Contents of Report

The remainder of this report provides an outline of the approach followed and findings. Details of the model, survey results and sources are given in Annexes.

In detail, Section 3 describes the approach.

Section 4 describes the findings.

Annex 1 provides information about running the model.

Annex 2 provides a description of the survey of Providers.

Annex 3 provides sources of information.

Annex 4 provides modelling results

3 APPROACH ADOPTED

3.1 Categorisation of Communications Providers

There are Providers of a Public Electronic Communications Network ("PECN") or Providers of a Public Electronic Communications Service ("PECS") that have taken one or more number blocks. Providers vary significantly in the volume of customers for geographic numbers, their geographic extent and their maturity. Some are mature, and are unlikely to require substantial volumes of additional numbers unless the market changes, whereas others are immature, and will continue to require more numbers even if the underlying demand for numbers does not change. We have therefore defined the following categories depending on their characteristics of demand:

- BT
- NTL / Telewest
- Traditional Providers (7 Providers)
- New Providers. (174 Providers)

BT is a specific category and was determined to have a unique characteristic of demand. BT maintain blocks allocations in virtually every area code and therefore has universal coverage. In terms of forecasting, we concluded that the demand for further block allocations from BT would be minimal.

NTL / Telewest also exhibit unique characteristics of demand. They retain allocated blocks within areas where they have infrastructure constructed. We consider that their demand profile for blocks will be stable since they do not currently have build programmes into new areas. Nevertheless, our modelling of New Providers could be considered to accommodate NTL or Telewest acting outside the areas that they have cabled.

Traditional Providers comprise operators that have traditionally built infrastructure in business centres and elsewhere on a piecemeal basis. Traditional Providers include: Kingston Communications and C&W. We believe that they are mature companies that provide direct access services. We believe that the number of operators acting in this way is stable, although individual operators may request more blocks as their business grows, and they may enter new areas like New Providers.

New Providers include ISPs and other new companies offering mainly voice over IP services and number translation services. We consider that the majority of demand for geographic numbers, particularly in areas outside major conurbations will come from this segment of the market. The market is immature and new companies may enter the market and may themselves require number block allocations. In addition, while some New Providers have established themselves in all area codes, most have not, and have agreed to a rationed approach. This rationing means that they obtain new area codes in batches that can be supported by Ofcom. Thus, New Providers are likely to have increasing demand for new blocks mainly but not exclusively in areas where they have yet to acquire number blocks. Our model therefore needed to forecast for both the number of operators per area and the number of blocks required.

3.2 Provider review

We contacted 14 New Providers to review requirements for geographic numbering to gain a better understanding of the demand for numbers from this group and have received eight responses. The Providers that we contacted are listed in Annex 2 and the overall response summarised.

These Providers offer VoIP, Internet Access services, and hence able to provide VoIP, number translation services and in-bound call centre services. They provide either wholesale or retail services and in some cases both.

The questionnaire that we used is also provided in Annex 2.

In addition, we interviewed Peter Gradwell of the Internet Telephony Service Providers Association (ITSPA). A summary of that interview can also be found in Annex 2.

3.3 Analysis of demographic and economic factors

Each area code was characterised in terms of:

- The number of telephone numbers in use within an area code
- The prosperity of each area code as characterised by the Gross Value Added (GVA) per capita by businesses and Gross Disposable Household Income per capita
- Growth in numbers of households within an area code; growth in number of households was considered to be a reasonable proxy for the underlying growth in geographic number demand within the area code for both consumer and business sectors.

Data on the number of telephone numbers in use by area code was made available from Ofcom.

We obtained GVA and GDHI information from the Office of National Statistics at a NUTS3 level. Individual area codes were assigned to NUTS3 regions.

We obtained household projections from planning documents published by regional assemblies, local authorities, and the Scottish Executive. We used historic data where no projections were available. In Growth Areas, we used local authority plans to provide more detailed analysis of growth.

Growth in numbers of households in an area code was determined by assigning the area code onto a local authority area, typically a county, a district or a unitary authority. Where overlaps occurred the area code was mapped onto the local authority area containing a town. Very few local authorities comprised more than one town.

3.4 Analysis of trends

We analysed trends in demand for number blocks based on the demographic and economic factors listed above using regression analysis.

3.5 Modelling

We prepared a model to forecast areas that are likely to become short of number blocks within the next ten years using the identified trends and relationships. This model takes account of growth in the underlying demand for numbers arising out of demographic change and the changing relationship between number of Providers with number blocks in an area and the numbers used in an area.

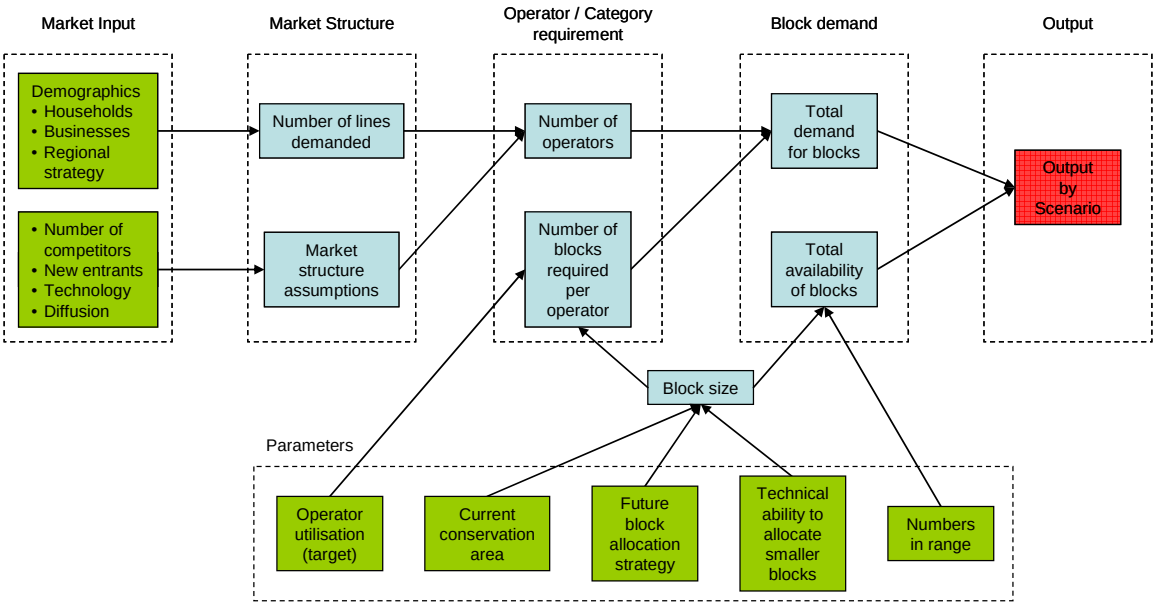

Figure 2: Basic Model Structure

3.5.1 The Basic Model Structure

Figure 2 above provides an overview of the basic model structure as agreed with Ofcom at the commencement of the project. The basic model structure takes source data (shown as green), performs manipulation (shown as blue) and generates the output, primarily for scenario appraisal (shown as red).

The model has been constructed to analyse each of the 790,000 number capacity area codes, I.e. four digit area codes. In some cases, where 5-digit codes have been allocated beneath the 4-digit code, reductions in the available capacity of numbers and blocks available for allocation are included. The model does not consider London area codes and area codes with 7.9 million numbers. This is based on our analysis of number utilisation and in discussions with Ofcom where we perceive sufficient capacity through existing allocations and unopened code blocks will satisfy demand over the plan period.

The primary source for base data was the public information on Ofcom's internet web site providing listings of 10K and 1K geographic number block allocations. This base data was manipulated through an access database to provide appropriate categorisation, area code classifications and time trend information to enable us to perform the statistical analysis.

The information contained within these files provided key information about which blocks which were considered as:

- Free
- Free for National Dialling Only
- Protected
- Allocated

In addition, for each allocated block, the file identified the Provider which had received the allocation. The file also contained a 'block change date' which we used as a proxy for the date of block allocation to allow us to investigate the trend in blocks and operators from 2002 to 2005. Ofcom agreed that, within the date ranges investigated, this would provide a reasonable estimation.

On direction from Ofcom, we considered blocks shown as 'Free' or 'Protected' as available for allocation. Blocks shown as 'Free for National Dialling Only' were considered as unavailable for allocation. Where the model predicted a requirement for new number block allocations, we first allocated blocks shown as 'Free', then allocated blocks shown as 'Protected'. If further number blocks allocations were forecast, the area code was shown to have block expiration in that year.

Where area codes were shown as conservation areas, allocations are made on the basis of 1K blocks. The base Ofcom data contains a separate file for 1K block allocations. This file supplements the existing 10K block allocation files. i.e. if an area is considered as conservation 10K blocks within that area are either protected or allocated to the 1K file under the 10K allocation code of 'mixed operators'. 1K blocks are then allocated to Providers from the 1K allocation file. In terms of the modelling, we have maintained this relationship. i.e. 10K blocks are first allocated to 1K blocks and then to individual Providers as required.

3.5.2 Modelling the Relationships

The heart of the model uses a forecast sheet to model the fundamental relationship between the number of Providers and the Numbers in use for each area code. The detailed modelling is discussed more fully in the following sections. Fundamentally, we forecast the demand for underlying numbers, translate this to a theoretical number of Providers by area code based on historical trend and forecast data, review high level market share assumptions and determine the block requirements.

3.5.3 Generating the Results

Due to the difficulty in establishing definitive trends in the base data, and the fundamental disconnect between the demand for numbers (which we can forecast directly), and the demand for number blocks (which we must forecast indirectly due to artificial factors such as block size and little cost to the Provider), we have used scenario analysis as the primary output for the model.

Scenario analysis effectively applies bounded, variable inputs to the model and performs a number of iterative variations. Analysis of the clusters of results allows us to understand the critical input factors and the most likely outcome based on probability.

Using scenario analysis allows the user to specify the boundary conditions. A random value is then generated within those conditions and the results tested. This type of analysis is appropriate for this model because it allows

1. The analysis and review of multiple uncertain variables.

2. Assessment of certainty to the results obtained.

We concluded that including a scenario driven output would therefore be the most appropriate result from this model. The performance of a full scenario evaluation is describers in more detail below. In addition to a full scenario review, the model contains flexibility to allow a review of individual area codes where required.

4 MAIN FINDINGS

We investigated the drivers for and characteristics of changes in demand for geographic numbers in two ways:

- By interviewing selected Providers
- By analysing trends in the number of Providers requiring number blocks by area code
- By analysing the number of blocks taken by Providers by area code

4.1 Changes in end-user demand

We were able to differentiate between change in underlying user demand for numbers and change in the demand for number blocks.

Change in the underlying demand for numbers is arising from the following:

- An overall reduction in the number of lines in use
- Changes in the number of households and businesses in specific area codes
- In the future, the potential for personal geographic numbers associated with VoIP
- Increase in VoIP call centres that provide geographic numbers in area codes to meet their customers' choice for in-bound calls

4.2 Change in demand for geographic number blocks

The change in demand for number blocks is arising mainly from the increase in the number of VoIP Providers and those providing VoIP based call centres. VoIP Providers find that:

- VoIP is currently being used in addition to the PSTN, and hence requires new numbers
- Where VoIP is replacing access to the PSTN, it is often quicker to obtain a block of numbers from Ofcom than to port a number from the previous Provider

A distinction can be made between Providers of wholesale services and Providers of retail services in terms of the volume of numbers required and the extent of their coverage of area codes.

Providers vary when asked whether their business depends on numbers in specific area codes being available. Some indicated that a nearby urban area code would be satisfactory to most customers, whereas others indicated that the ability to provide a number in any area code was part of what made their service unique.

4.3 Identification of notable regional or local differences in demand, for example, influenced by new build developments in particular areas

We investigated regional spatial plans for the whole country to find out where development is intended to take place.

4.3.1 Number of lines in the country as a whole

The number of exchange lines in use declined by 4.2% from Q3 2004 to Q3 2005 after a period of two years of decline of about 1% pa. In our modelling therefore we have assumed that the overall size of the market is declining at the rate of 0.73% pa which is the average from Q3 2002 to Q3 2005.

The reasons for this more marked decline are a "growth in mobile-only homes and a fall in the number of second lines for dial-up internet access"[1] Whether this decline in number of exchange lines will be sustained is not clear. Access charges increased during 2005, and this may have suppressed demand. If this is so, then the decline in 2005 may be a one off event rather than a continued feature of the access market. However, we believe that it is also likely that the impact of mobile telephony and broadband on the number of exchange lines in use will continue for some time, and that VoIP may have a further effect by encouraging business users to replace multiple lines with a single broadband connection to a VoIP service capable of handling a number of calls simultaneously. If this happens, then the number of business lines, particularly in small and medium sized enterprises may decline.

The impact of the marked decline in 2005 in number of exchange lines in use would not have affected the attractiveness of area codes to Providers since this decline would not have been apparent to them until the Ofcom report was published by which time decisions to request specific area codes would have been made.

4.3.2 Demographic change and impact on exchange line growth

The number of households is forecast to grow in most local authority areas, despite some areas with falling populations. Nevertheless, the impact of a decline in demand for lines suggests that the overall numbers in use arising purely from demographic change will decline overall. We have therefore forecast the rate of growth (decline) in numbers in use by area net of the overall rate of decline in exchange lines.

Figure 3 below shows the frequency distribution of area codes by rate of growth. This indicates that 17 out of 611 area codes are likely to exhibit a growth in numbers in use.

Within any area, there is an emphasis on building on brownfield sites, protection of the countryside and high density of provision. As a consequence we anticipate that much new build will be near or within urban areas. As area codes generally cover towns and surrounding countryside, we have concluded that the impact on local differences in demand will be negligible.

[1] Ofcom: The Communications Market Interim Report, February 2006, Page 56

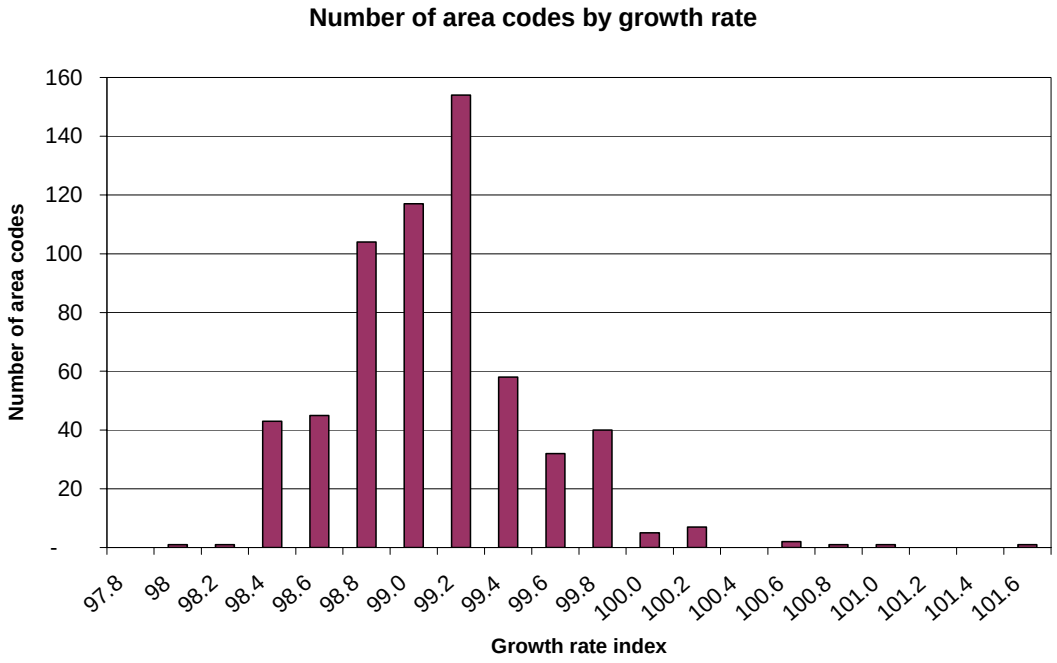

Figure 3: Number of area codes by growth rate

4.3.3 Relationship between exchange lines and numbers in use

Until recently, the telephone numbers were roughly related to the number of exchange lines, excepting the use of hunt groups and number translation services.

The introduction of VoIP has meant that this relationship has broken down. In particular:

- Geographic numbers may readily be used out of area by a VoIP Provider since there is no linkage between the number and physical infrastructure. We found in interviewing Providers that call centres may have multiple geographic numbers that reflect the geographic location of the companies that subscribe to the call centre services rather than the geographic location of the call centre itself.

- VoIP allows for personal geographic numbers. The number is assigned to an individual or a phone and not to a line. Hence a single broadband connection can have multiple numbers associated with it. This may mean that a household may have two or three DDI numbers.

- VoBroadband allows for multiple simultaneous calls on a single broadband connection. Therefore business users may reduce the number of exchange lines used and at the same time migrate to DDI.

We have not found any data to enable us to model any trends associated with these possibilities, and have therefore not included them in our modelling. However, we believe Ofcom should review the relationship between lines and numbers periodically in order to identify trends when they become apparent.

4.4 Identification of notable variations in growth within the year on year trends

4.4.1 Number of Providers with number blocks in an area

We identified a relationship between the number of Providers with number blocks in an area code and the number of geographic numbers in use within the area code. Figure 4 below demonstrates the relationship between the numbers in use and numbers of Providers for years 2002 to 2005, and shows how the trend varies from one year to the next. We found that in any one year a linear regression provided the best fit except in 2005 when a logarithmic regression gave a slightly better result. From one year to the next the regression changed in two factors:

- The number of Providers overall grew substantially and was accelerating.
- The number of Providers in those areas with a larger number of geographic numbers in use grew faster than in those areas with a smaller number of geographic numbers in use.
- Nevertheless, the number of Providers in smaller areas grew.

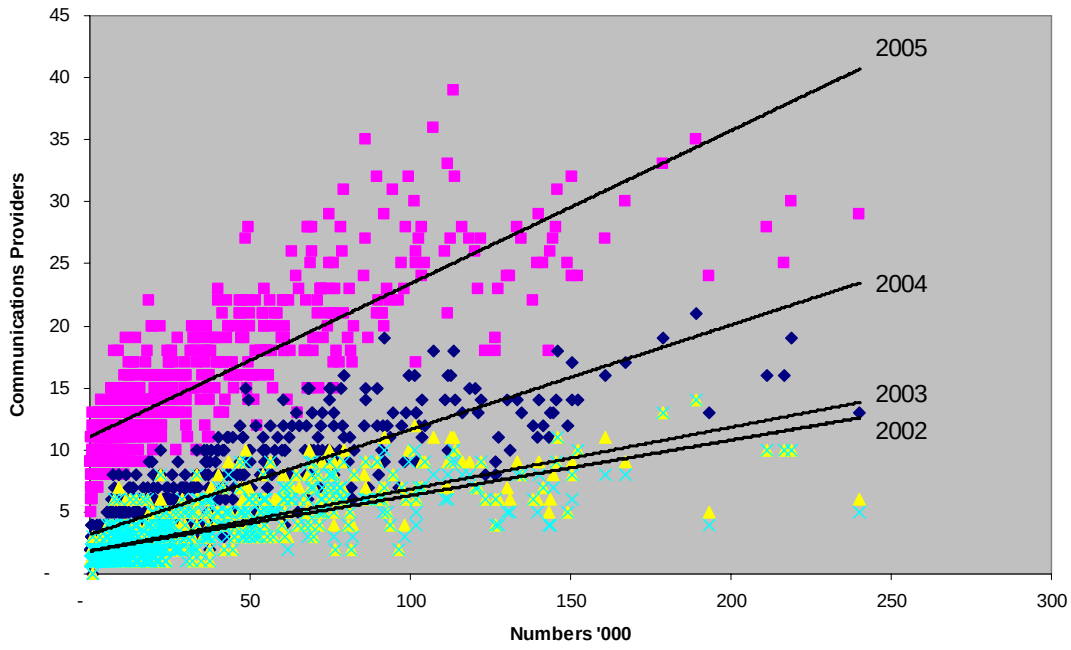

Figure 4: Relationship between the Number of Providers and Numbers in Use by Year

The small number of operators in years 2002 to 2003 is indicative of the need, before VoIP for operators to have physical presence in an area for direct access. Thus, only a small number of Providers could make extensive use of geographic numbers, while a larger number of Providers might provide services in metropolitan areas. We believe that the number of Providers in 2004 and 2005 represent increasing demand for numbers from New Operators, particularly for VoIP services and NTS.

We also asked Providers on what basis they requested numbers. They told us that they tended to use the number of number in use within an area or similar data as a proxy for demand.

4.4.2 *Understanding year on year trends in the number of Providers in an area*

The key challenge from this statistical analysis is to evaluate and understand year on year trends in the number of Providers in an area.

As the number of Providers is limited, we believe that the growth in the number of Providers in an area cannot carry on for ever, and that growth will decelerate at some stage. We therefore matched the year on year growth in the number of Providers in any area to a Gompertz function.[2] The Gompertz curve is a traditional curve based on a combination of an exponential and a logarithmic curve. The result is an S-curve driven by the initial value, the growth rate and a ceiling.

We chose to analyse the graph at two points: first, amongst area codes with a small number of numbers in use and Providers to generate a view of the rate of growth from one year to the next in the number of Providers in such areas, and secondly, at the 150k level, to generate a view of rate of growth in areas with a large number of numbers in use and Providers. We applied a Gompertz curve to both the low end and high end areas and derived the relationship shown in Figure 5.

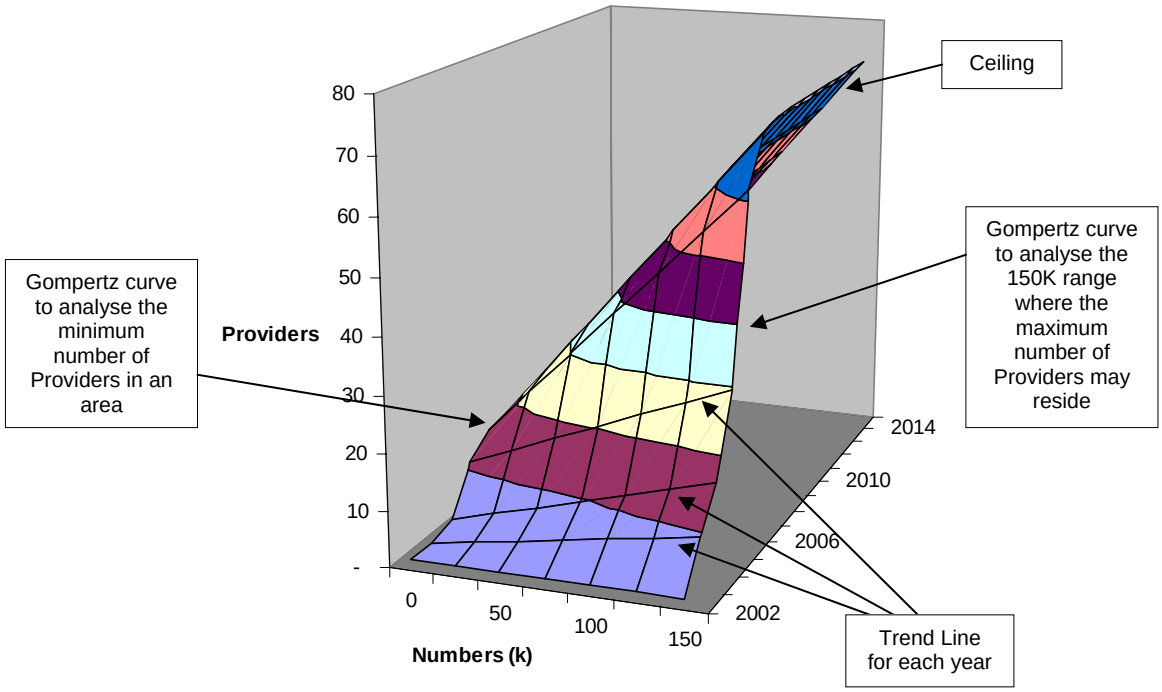

Figure 5: Forecast of the Trend Lines by Year

We used a scenario analysis to determine the overall shape of the curve, and in particular to identify the maximum number of operators (the ceiling) and the rate of growth in the number of operators from one year to another. We tested a variety of ceiling values for the 150K level to determine the significance of the input value.

What this curve shows is the relationship in any one year between the number of geographic numbers in use and the number of Providers in an area. It also shows how for a given area the number of Providers will change year on year assuming a constant volume of geographic numbers in use.

[2] We used the date when a block changed status to indicate the introduction of a new operator in an araea. Ofcom agreed that this was a reliable approach for the years 2002 to 2005.

As we have seen, the numbers of exchange lines is likely to reduce in most areas. This may have one of two effects. It may reduce the propensity of a Provider to enter a new area, or it may just change the Provider's priority weighting to each area code. We are of the view that the latter is more likely, since numbers represent only a small cost to a Provider, and they represent a value since they can better meet a customer's requirements.

4.4.3 The number of communications Providers and the number of blocks demanded

The number of geographic number blocks used in an area is dependent on the number of Providers and the share of numbers in use by each Provider. Each Provider in an area obtains at least one block irrespective of the numbers used by the Provider. Thus, the lower bound for the number of blocks required is equal to the number of Providers in an area.

Some operators will use all the numbers in their first block and will require subsequent blocks. The number of blocks that a Provider ultimately requires is dependent on the number of geographic numbers in use in the area and the Provider's market share. Overall, therefore, some Providers will have multiple blocks and some will have only one block.

In most areas, traditional Providers already have multiple blocks, but newer Providers typically have only one block and use only a small proportion of the numbers within that block. Some new Providers, particularly those offering wholesale services and the larger VoIP providers, and Providers in conservation areas with 1K blocks will require more than one block. The number of blocks they require will grow if they gain market share.

As it is too early to determine any trends in demand for numbers from these newer Providers, we have based our estimation of this additional demand for blocks on the following initial assumptions.

i) In 2005, new Providers use 3% of the numbers in any area.

ii) Three new Providers will share 40% of the numbers.

We believe that these assumptions mimic competition in call conveyance where carrier pre-select and other direct access has risen to 21% in Q3 2005 from a negligible proportion in Q3 2002[3].

In the model we assumed that three operators would take significant market share. This market share was investigated in scenario values based on randomly generated values within a normal distribution defined by a mean and standard deviation. Two operators were assumed to have a mean of 15% and standard deviation of 5%, while the third was assumed to have a mean of 10% and a standard deviation of 3%. The market size was assumed to be 1% each in 2005 and would grow to the ceiling ranges indicated above through a traditional Gompertz curve relationship. The market share for each of the three communications providers was multiplied by the market size to determine the numbers supported by that operator. This then provided, through utilisation specification, the requirement for more than one number block per operator.

[3] Ofcom: The Communications Market Interim Report, February 2006, Figure 41, Page 58

4.5 Operator Preference

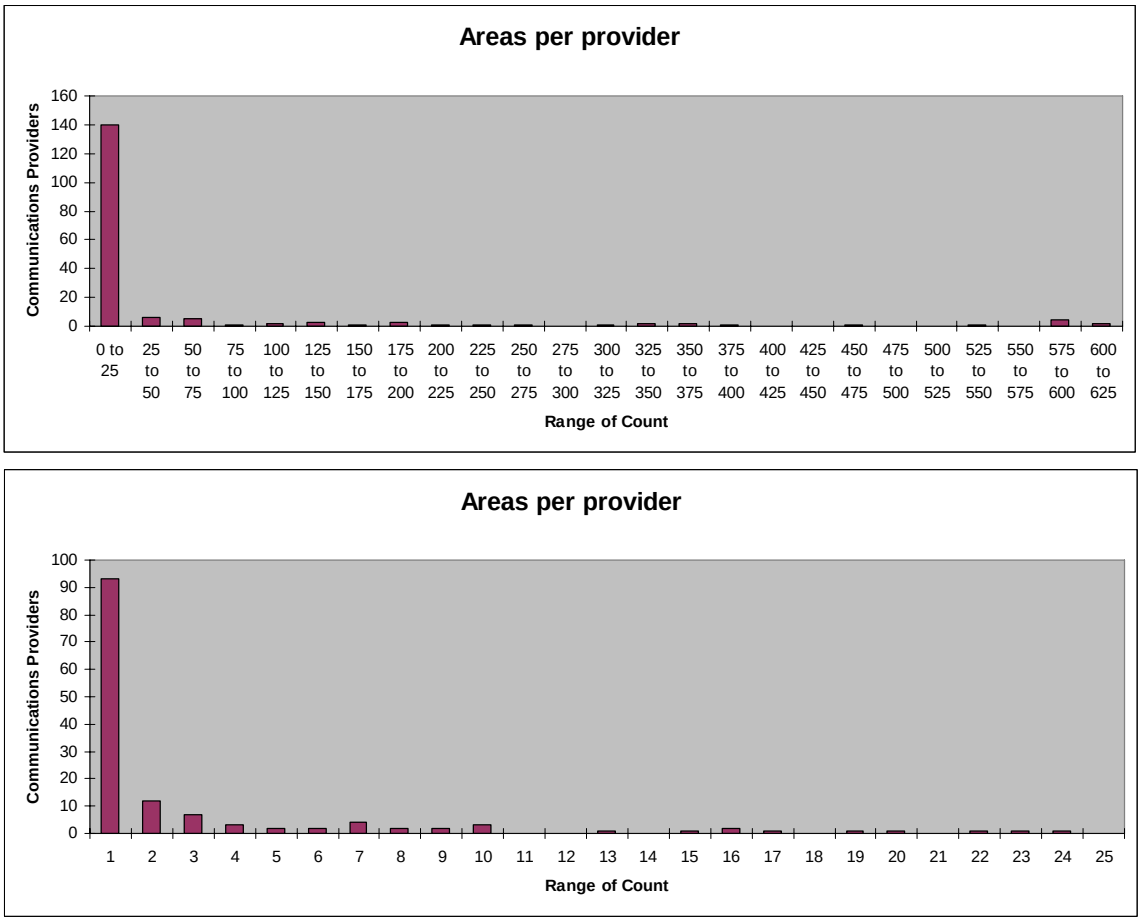

Figure 6: Providers Preference

Figure 6 above shows a count of the number of areas each Provider maintains number blocks within. The top graph shows the entire area code range in steps of 25, while the bottom figure expands on the 1 to 25 area code range.

It is quite clear from the above diagram that the majority of Providers maintain presence in only one area, and that, from analysis, the area most favoured is London.

4.6 Number of area codes suffering exhaustion

We concluded that the number of area codes suffering exhaustion at a given level of probability will increase through time based on the Monte Carlo simulation as shown in Figure 7 below. An extract of the model results showing area codes facing exhaustion is given in Annex 4.

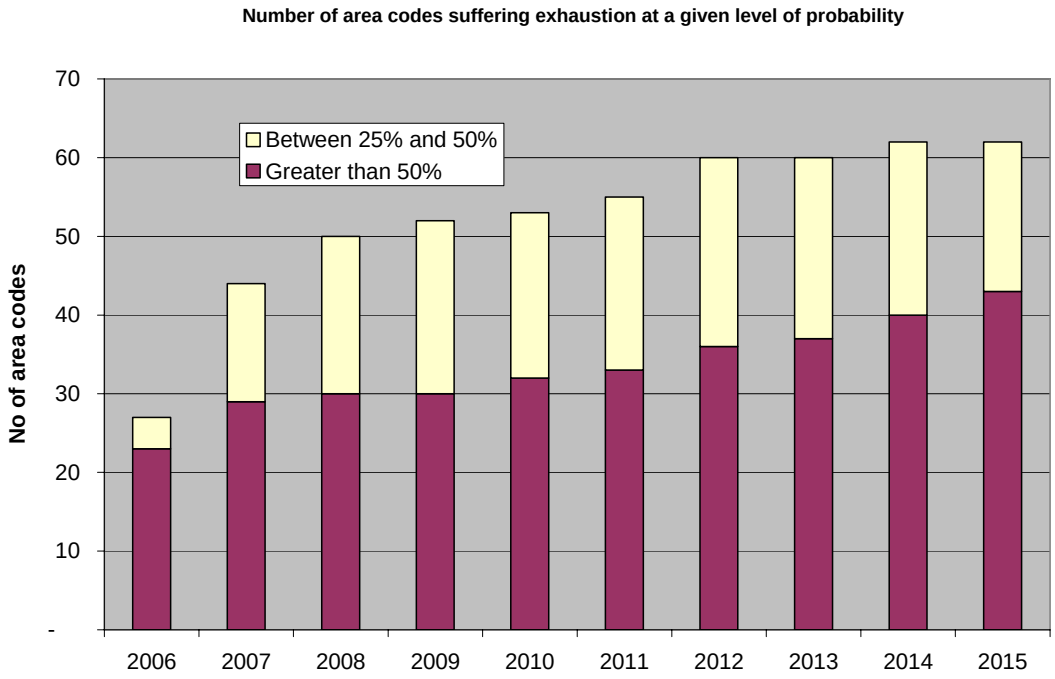

Figure 7: Number of area codes suffering exhaustion

Annexes

Annex 1: Detailed Review of the Model Operation

The model is structured into three sections:

1. Dataset
2. Forecast (including curve formula)
3. Results (Scenario and Individual)

1 DATASET

The dataset contains three separate sections and should remain static until the model and trends are updated. The three sections review the trends in number of operators and block allocations by area code over the period from end 2002 until end 2005. The first set contains basic area code information such as capacity, plus trends in the number of operators by category. The second data set contains trends in the number of 1K allocated blocks by category. The third set contains trends in 10K block allocations by category. In all cases the trends of operators and blocks have been grouped together in the four categories of BT, NTL / Telewest, Traditional Operators and Other Operators

2 FORECAST

Forecast takes information from the datasets, fits the demand curve and allocates the blocks. This is the heart of the model and is the section where the calculation occurs. The forecast worksheet takes information from the dataset on an area code by area code basis and performs the analysis based on the curve fit data and the trend in number of operators and blocks by operator. The forecast first generates trend information from the datasets as detailed above. Growth forecasts are then applied to the numbers in use as a proxy to the population and business attractiveness of each area code.

For forecasting purposes, the number of operators in the three categories of BT, NTL / Telewest and Traditional Operators remains constant. The movement in the number of communications providers within the 'Other Operators' category drives the demand for number blocks.

3 RESULTS

The model provides a forecast of those areas that are likely to run short of number blocks in the next ten years with and without action to conserve number blocks based on the use of 10K number blocks. For each area code and year the model gives a probability of block exhaustion in that year with and without action to conserve number blocks.

The model can automatically introduce conservation measures when it forecasts a shortage of number blocks in a given area, and can take account of such dynamic conservation measures in forecasting number block utilisation.

Results can be analysed in two different ways:

- Scenario based analysis of all area codes under variable conditions
- Analysis of an individual area code under certain conditions.

The model has been constructed to allow flexibility in the type of analysis performed. In some circumstance is may be necessary to review the impact on a specific area code from certain input

conditions. The following paragraphs describe how to operate the model for both types of analysis.

3.1 Performing a Dynamic Scenario Evaluation

The forecasting of number block demand is driven by a variety of uncertain factors and scenario analysis is the usual method for evaluating the impact from this uncertainty. A dynamic scenario evaluation is performed by selecting variables in the 'scenarios' sheet to either "Random", "Static" or "Mean". Variables comprise:

- Ceiling – the maximum number of operators in the area
- Market shares of the first three operators
- Growth in market shares
- Maximum utilisation of numbers
- Growth rate in underlying demand for numbers

When set to "Random", the model will generate a random value for the parameter which conforms to a normal distribution around the mean and standard deviation as defined by the user. For this parameter you should note that for normally distributed functions, 95% of the results will fit within approximately plus and minus two Standard deviations from the mean. A setting of 'random' allows the user to perform a dynamic scenario evaluation. For certain variables, conditions have been applied to the random variables generated. Any restriction condition is noted next to the variable.

When set to "Mean", the specific variable is fixed to the mean value. When set to "Static", the variable is fixed to a user defined static value. This allows the user to disconnect that particular variable from a scenario analysis and therefore allow the user to perform a dynamic scenario evaluation of the impact from changes in a subset of the input variables.

The user can also select the number of iterations to perform. The greater the number of iterations, the more accurate the results cluster will become. An iteration is performed on each area code in turn and while a high iterations setting will improve accuracy, it will also result in a longer model run. 100 iterations is generally sufficient, although there will be small changes in results from one run of the model to another at that level.

Once the parameters are fully defined the user commences the evaluation by running the macro '***Run_Scenario_Analysis***' by pressing the control button in sheet 'Scenarios'. The macro calculates the results from each iteration and, if the demand for blocks exceeds the available supply, the model records this event. Once all iterations have been performed for a particular area code, the percentage of instances of number exhaustion in a particular year is recorded in the 'Scenario Distribution' sheet. A high percentage indicates a high probability of number exhaustion within that year and for the parameter variables as set. A review of the scenario distribution results against the number of iterations, together with the frequency of block exhaustion provides an indication, within the bounds of certainty, of areas at risk.

Conservation measures can be defined in terms of a trigger level for application of conservation measures and the time period to look forward. The trigger level is specified as the number of blocks that have to be available in a given year in the specified period for conservation measures *not* to be taken. If the number of blocks falls available in a given year falls below that value then block size is changed from 10K to 1K.

The model then reports the impact on block exhaustion before and after any conservation status change. The outcome of a model run is given on sheet “Scenario distribution”. Six items of information are given by year for each area:

- Block expiration and cumulative block expiration pre status change
    - i.e. no number conservation measures are introduced
- Probability of status change in any given year and cumulative
- Block expiration and cumulative block expiration taking account of status change

3.2 Analysis of an individual area code under certain condition

The user can monitor the trends within a specific area code by setting the required parameters in the scenario sheet, and setting cell B2 in the forecast sheet to the required area code. Investigation can then be made of the trend forecasts.

Annex 2: Survey

1 FINDINGS

We interviewed eight Providers from a total of 14 to understand demand for number blocks by operators. The Providers contacted are given in Section 3 and the questionnaire used is given in Section 44. The responses from Providers are given in Section 2.

In addition we interviewed Peter Gradwell of the Internet Telephony Service Providers Association (ITSPA) about demand for geographic numbers. He made the following key points:

- Most VoIP providers currently serve green field sites and so need new numbers to allocate.
- However, he expects the majority of VoIP provision will arise from churn from existing numbers. This is unlikely to reduce number demand though, as number portability is difficult and it is usually easier to issue a new number.
- There is disproportionate demand for London & Manchester codes. A significant proportion of Peter's clients are offshore and nearly all have been allocated London numbers.
- Most end users invariably want a recognisable geographic number. No-one is interested in the 05 range, for instance as they are not seen as 'credible' (i.e. charge rates unclear and meaning of number unknown). There is high demand for geographic numbers that reflect the user's location (for example for taxi drivers etc). Therefore, demand in specific area codes cannot be moved to another area code.
- In the longer term Peter's view (which is shared by ITSPA in general) is that the number of operators will increase markedly. However, numbering could readily be personalised. When the 21CN is in place, the current block size limitation disappears and it will be viable to implement eNUM, which would make number portability easy.

2 PROVIDER RESPONSES

2.1 Services offered that require geographic numbers

Respondents mentioned the following services:

	Number of mentions
Direct access	3
Future VoIP	2
Current VoIP (via Broadband)	4
Number translation	2

2.2 Factors determine the area codes where blocks are requested

Customer location was the main reason for requesting blocks in particular area codes for those Providers that provide direct access but do not provide VoIP. Typically, they want area codes in major cities.

Providers that offer VoIP tend to obtain number blocks in advance of customers to meet anticipated demand. One wholesale Provider indicated that VoIP Providers prioritise blocks in areas with a large number of geographic numbers in use, exchange lines or a large population. Two VoIP Providers who responded also mentioned prioritisation of high tech and industrial locations over other areas. Two others mentioned university towns. However, VoIP Providers would prefer to have blocks in all areas. This is particularly important for wholesalers. Some VoIP Providers mentioned that they phased their requests for blocks, asking Ofcom for around ten blocks per month. This appeared to be done to help Ofcom rather than for any particular business reason.

One Provider indicated that its business model entailed having number blocks in every area code.

2.3 Frequency of requests for blocks in new areas and the number of areas requested each time

The operators that offer direct access, and do not offer VoIP, rarely request blocks in new areas and only require 1K blocks.

Most Providers indicated that they were unlikely to use an allocation of 10K blocks and two Providers indicated that they would prefer to have 1K blocks even though they might have to request further blocks. One indicated that 1K would be sufficient in most but not all areas. One indicated that this was because of concerns about requests for the return of unused portions of blocks if a shortage of numbers developed.

2.4 Impact of porting numbers from other Providers

Three Providers indicated that they did not port from other Providers.

Where Providers had an agreement for porting numbers in a particular area, porting generally happened within a few days. Numbers in these areas could therefore be reused. However, agreements were generally viewed as difficult to establish. It generally took a few months to reach agreement with other Providers. Therefore Providers reported that they had to enter into agreements in advance of demand for porting.

One Provider indicated that end users drew a distinction between the transfer of existing service to a new operator and new services. End users generally wanted numbers to be ported on transfer of an existing service, whereas they generally required a new number for a new service. VoIP is currently viewed as a new service by most customers. Only when proven will they want to port numbers. Thererfore, current demand for VoIP is not by itself leading to an increase in the number of ported numbers, but as VoIP matures porting numbers may become more of a requirement.

2.5 Requests for additional blocks

Three Providers, all wholesalers, indicated that they would require further 1K or 10K blocks. One indicated that it would require additional 1K blocks in a relatively large number of areas, but would require 10K blocks in only a few areas. Another thought that it was unlikely that it would require additional 10K blocks. The third thought that it would need more numbers in the London area and eventually in other metropolitan areas and in areas with 1K blocks.

Two operators mentioned personal geographic numbers as a potential reason for them to request further numbers. One gave as an example the provision of personal geographic numbers to university students. Another thought that personal geographic numbers for family members may become important.

2.6 Impact on ability to address markets from a lack of numbers

One Provider indicated that it was not necessary to give a number with the correct area code for the address of the customer in all cases. Rural customers would generally accept an area code associated with a nearby town. However, urban customers generally required the corresponding area code.

Three providers indicated that the provision of a number in any area code was necessary to its business. Two other Providers indicated that it would have little impact on their business. One of these Providers used numbers in the 00845 range for its VoIP service.

3 PECN AND PECS CONTACTED

	Interviewed
Aggregated Telecom Ltd	x
Centrica Telecommunications	
Cheers International Telecom Ltd	
Citrus Telecommunications Ltd	x
Coulomb Ltd	x
Danemere Street Creative	
Easynet Group Plc	x
Inclarity plc	x
Interweb Design Ltd	
Magrathea Telecommunications Ltd	x
Opal Telecom Ltd	
Pipemedia Ltd	
PlusNet PLC	x
VTL (UK) Ltd	x

4 QUESTIONNAIRE:

1. What services do you offer that require geographic numbers?

2. What factors determine the area codes where you request blocks?

3. How frequently do you request blocks in new areas? How many areas do you request each time?

4. What proportion of numbers do you port from BT or another Provider in relation to new numbers?

5. What is the impact of the time taken to port numbers on the proportion of numbers that you port from BT or another Provider?

6. Do you envisage needing to request additional blocks in any area codes?

7. What types of area code would those be? Urban/rural? What region?

8. What limits if any are placed on the markets for your services by not having area codes for specific locations?

Annex 3: Principal Data Sources

1 PRINCIPAL SOURCES

Data is based on the following primary sources:

- Ofcom information on number blocks
- Ofcom provided utilisation and numbers in use based on BT's database.
- NUTS3 region Gross Value Added (GVA) and Gross Disposable Household Income (GDHI)
- ODPM housing and developments planned
- Interviews with specific communications providers.

2 OFCOM INFORMATION BLOCKS INFORMATION

Data for 10K block allocations was sourced from:

- Code and number blocks - 1130 00 to 1599 99 on file sabcd1.xls
- Code and number blocks - 1600 00 to 1997 99 on file sabcd2.xls
- Code and number blocks - 2000 00 to 2920 99 on file sabcd3.xls

Where area codes are considered as conservation areas in terms on number block exhaustion, allocation is made in blocks of 1K. Details of these allocations was sourced from:

- Download Geographic Number Ranges (MS Excel format) on file s1f.xls

3 REGIONAL GROSS VALUE ADDED (GVA) AND GROSS DISPOSABLE HOUSEHOLD INCOME (GDHI)

GVA source: Office for National Statistics: Gross value added per head by NUTS3 area at current basic prices, 2003

GDHI source: Office for National Statistics: Gross disposable household income (GDHI) per head by NUTS3 area at current prices, 2003

4 ODPM HOUSING AND DEVELOPMENTS PLANNED

East of England: Regional Planning Guidance for East Anglia to 2016, November 2000; East of England Plan - Draft revision to the Regional Spatial Strategy (RSS) for the East of England, December 2004

East Midlands: Regional Spatial Strategy For The East Midlands (RSS8), March 2005 Policy 17 – Regional Housing Provision; Milton Keynes & South Midlands Sub-Regional Strategy - Technical Note on Housing Numbers, February 2005, Table 2: District and Unitary Housing Provision in SRS and Building Rates

London: Office of National Statistics Table 3.19 Household numbers and projections

Northern Ireland: Household Projections for Northern Ireland: 2002 -2025 Northern Ireland Statistics and Research Agency

North East: Source: Regional Planning Guidance for the North East (RPG1), 2002, Table 4.4 Indicative Annual Average Rates of Housing Provision post 2006

North West: Submitted Draft Regional Spatial Strategy for the North West of England, January 2006, Table 9.1 – Distribution of Regional Housing Provision 2003-2021

Scotland: Scottish Executive Statistical Bulletin Household Projections for Scotland: 2002-Based, April-04

South East: Regional Planning Guidance for the South East (RPG 9), March 2001; RPG9 Amended Chapter 12, Ashford Growth Area 2004; Kent and Medway Structure Plan, Working Paper 1, Trend and Strategy Based Population, Household and Dwellings Projections 2001-2021, September 2003, Table 13: Dwelling change: Policy Based Forecast: Kent Districts and Medway; Milton Keynes & South Midlands Sub-Regional Strategy, Technical Note on Housing Numbers, February 2005

South West: Source: Regional Planning Guidance for the SouthWest (RPG 10), September 2001

Wales: Regional Planning Guidance for North Wales, Adopted. October 2002; Regional Planning Guidance For South West Wales, Table 2: Welsh Office Household Projections 1996-2016, April 2000; Strategic Planning Guidance for South East Wales Vol 1, Table H1, South East Wales Strategic Planning Group, 2000; Office of National Statistics, Mid-year Household Estimates for Wales 2001 to 2003

West Midlands: Regional Planning Guidance for the West Midlands, p37 Table 1

Yorkshire and Humber: Source: Regional Spatial Strategy for Yorkshire and the Humber (2004), Table H1 Housing Provision 1998-2016 and Provisional Targets for Previously Developed Land

Annex 4: Model Results

The table below shows the cumulative probability of block exhaustion by a given year without any conservation measures. It is an extract from the model results showing the area codes with the highest probabilities.

Scenario Results		Cumulative Probability									
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1482 Hull		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
1253 Blackpool		96%	96%	96%	97%	97%	97%	97%	97%	97%	98%
1634 Medway		94%	95%	95%	95%	95%	95%	96%	96%	96%	96%
1633 Newport		93%	93%	93%	93%	93%	94%	95%	95%	95%	95%
1268 Basildon		93%	93%	94%	94%	94%	95%	95%	95%	95%	95%
1708 Romford		93%	93%	93%	94%	94%	95%	95%	95%	95%	96%
1384 Stourbridge		91%	92%	92%	92%	93%	93%	94%	94%	94%	94%
1706 Rochdale		91%	91%	91%	92%	93%	94%	94%	94%	95%	95%
1484 Huddersfield		90%	91%	91%	91%	92%	93%	94%	94%	95%	95%
1494 High Wycombe	B	88%	89%	90%	90%	91%	92%	93%	95%	95%	95%
1702 Southend-on-Sea		88%	89%	89%	89%	91%	91%	91%	92%	92%	92%
1709 Rotherham		86%	87%	88%	88%	89%	90%	90%	91%	92%	92%
1302 Doncaster	B	86%	87%	87%	87%	88%	88%	89%	90%	90%	90%
1903 Worthing		84%	85%	85%	86%	87%	87%	88%	89%	89%	89%
1932 Weybridge		83%	86%	86%	86%	86%	87%	88%	89%	89%	90%
1952 Telford		82%	86%	86%	87%	87%	88%	89%	91%	91%	92%
1206 Colchester		78%	82%	82%	82%	83%	84%	86%	86%	87%	88%
1244 Chester	B	74%	79%	79%	80%	80%	81%	83%	83%	84%	85%
1225 Bath		72%	79%	80%	80%	80%	82%	84%	85%	86%	86%
1443 Pontypridd		71%	77%	78%	79%	80%	81%	82%	83%	83%	84%
1226 Barnsley	B	68%	78%	78%	78%	79%	81%	82%	83%	85%	85%
1623 Mansfield		61%	71%	71%	71%	72%	74%	75%	76%	77%	77%
1234 Bedford		51%	70%	73%	74%	75%	77%	79%	80%	81%	83%
1992 Lea Valley		45%	66%	67%	68%	69%	70%	72%	73%	74%	75%
1246 Chesterfield		45%	64%	65%	65%	66%	68%	70%	70%	71%	72%
1256 Basingstoke		29%	52%	55%	55%	55%	56%	57%	59%	61%	63%
1279 Bishops Stortford		29%	53%	55%	55%	56%	57%	59%	60%	62%	62%
1282 Burnley		19%	51%	53%	53%	53%	54%	55%	57%	58%	60%
1803 Torquay		17%	51%	53%	53%	55%	57%	59%	62%	63%	65%
1243 Chichester		14%	48%	50%	51%	51%	53%	54%	56%	57%	58%
1905 Worcester		10%	47%	49%	49%	49%	50%	51%	53%	54%	55%
1926 Warwick		6%	40%	43%	44%	44%	45%	46%	49%	50%	51%
1322 Dartford		6%	42%	45%	46%	47%	49%	51%	53%	54%	55%
1245 Chelmsford		4%	39%	43%	44%	44%	45%	47%	48%	50%	51%
1628 Maidenhead		4%	36%	39%	40%	40%	41%	42%	43%	45%	46%
1622 Maidstone		4%	34%	38%	38%	38%	39%	40%	42%	43%	44%
1323 Eastbourne		3%	35%	39%	40%	41%	42%	44%	45%	46%	47%
1236 Coatbridge		2%	29%	32%	33%	33%	34%	36%	38%	39%	40%
1442 Hemel Hempstead		2%	25%	29%	30%	30%	30%	32%	33%	35%	37%
1242 Cheltenham		2%	30%	34%	36%	37%	38%	40%	41%	44%	46%
1827 Tamworth		1%	25%	29%	29%	30%	30%	30%	31%	31%	32%
1392 Exeter		1%	28%	32%	33%	34%	35%	36%	38%	40%	42%
1293 Crawley		1%	25%	30%	30%	30%	31%	32%	32%	34%	36%
1276 Camberley	B	1%	26%	30%	30%	30%	30%	30%	30%	30%	31%
1922 Walsall		1%	25%	30%	31%	31%	32%	34%	35%	36%	37%
1506 Bathgate		0%	19%	23%	25%	26%	29%	31%	34%	36%	39%
1625 Macclesfield		0%	21%	27%	27%	27%	27%	28%	30%	31%	32%
1472 Grimsby		0%	18%	24%	25%	25%	25%	26%	27%	29%	30%
1536 Kettering		0%	29%	34%	36%	37%	39%	43%	46%	50%	51%
1527 Redditch		0%	20%	25%	26%	26%	26%	27%	27%	29%	30%
1732 Sevenoaks		0%	10%	16%	17%	17%	17%	18%	18%	19%	21%
1522 Lincoln		0%	12%	18%	19%	19%	19%	20%	21%	23%	25%
1543 Cannock		0%	19%	24%	24%	25%	26%	27%	29%	31%	32%

Figure 8: Area codes most at risk of running out of number blocks

Figure 9 below shows the impact of changing block size from 10K to 1K for an area code that has a high probability of number exhaustion. “Block Allocation Pre Status Change” shows the probability each year of number exhaustion in that particular area code. The cumulative probability is shown in the next line. “Probability of Status Change in any given year” shows the probability that number conservation measures have to be introduced in that year. “Block Expiration Post Status Change” shows the probability each year of number exhaustion once number conservation measures have been introduced. This example is typical of the many area codes that face number block exhaustion where conservation measures are beneficial.

Area code	Location	Current Conservation status
1242	Cheltenham	

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Block Expiration Pre Status Change	0%	46%	9%	3%	0%	3%	5%	5%	0%	3%
Block Expiration Pre Status Change - Cumulative	0%	46%	55%	58%	58%	61%	66%	71%	71%	74%
Probability of Status Change in any given year	68%	6%	4%	1%	2%	1%	0%	2%	1%	0%
Cumulative Probability of Status Change	68%	74%	78%	79%	81%	82%	82%	84%	85%	85%
Block Expiration Post Status Change	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Block Expiration Post Status Change - Cumulative	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Figure 9: Example of the impact of conservation measures on number block exhaustion

Figure 10 shows an area code where number conservation measures have already been introduced and is still facing number block exhaustion.

Area code	Location	Current Conservation status
1223	Cambridge	A

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Block Expiration Pre Status Change	0%	0%	2%	9%	14%	24%	12%	19%	8%	4%
Block Expiration Pre Status Change - Cumulative	0%	0%	2%	11%	25%	49%	61%	80%	88%	92%
Probability of Status Change in any given year	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Cumulative Probability of Status Change	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Block Expiration Post Status Change	0%	0%	2%	9%	14%	24%	12%	19%	8%	4%
Block Expiration Post Status Change - Cumulative	0%	0%	2%	11%	25%	49%	61%	80%	88%	92%

Figure 10: Example of an area code where conservation measures have already been introduced