Finer Digit Analysis of Telephone Numbers for Routeing Purposes

REPORT TO OFCOM

11 August, 2005

Issue 1.0 Ref: 00720/RT/818.1.

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SUMMARY OF FINDINGS

The key question addressed in this report is whether it is reasonable to ask operators to carry out finer digit analysis, thereby allowing numbers to be allocated in smaller blocks. This question is examined for geographic, non-geographic and mobile numbers and the answer, in each case, is that the wholesale implementation of finer digit analysis is possible but that this is not without consequence.

At the heart of this issue is the amount of available data decode resource. The allocation of smaller number blocks requires a deeper analysis of digits to route a call and this analysis consumes decode resource. All network switches have a finite decode capacity and, in the case of the long established System X and Ericsson AXE 10 systems, it is not viable to upgrade that capacity.

In order to establish the technical limits of installed network equipment and the extent to which finer digit analysis will likely test those limits, detailed input has been sought from operators. The bulk of this report is an analysis and discussion of the input received. Of particular relevance to the main question are the facts that:

- The available decode resource on both System X and AXE 10 switch (which represent the limit on finer digit analysis for both geographic and non-geographic numbers) is constrained and not extensible but is nonetheless adequate to support many more number conservation areas.

- The way in which decode resource is consumed in these two types of switch varies significantly with the majority of System X decode blocks used by local subscriber decode and the use of AXE 10 decode lines most affected by non-geographic ranges.

- This variation means that the ability to support many more conservation areas could quickly be compromised by other regulatory measures that compete for data decode resource. In particular, the way in which AXE 10 decode is organized make it vulnerable if there is an expansion in the use of non-geographic numbers. The most pressing limit on System X switches appears to be the availability of the destination categories used to select an appropriate path once decode is complete.

- The decode space available to mobile network operators poses no barrier to the allocation of smaller number blocks but the attendant requirement to analyse an extra digit of the dialled number would require time so that foreign operators are made aware of the change in the UK plan.

Given the above, it is clear that there is no overarching technical reason to limit the introduction of finer digit analysis. However, because number conservation is not insulated from other regulatory measures, the utilisation of decode resources needs to be managed as a whole. The fact that there is a different sensitivity to particular changes between the installed network equipments underlines the need for this. A regular audit of the cumulative effects of regulation is therefore recommended as a sound basis for overall policy.

1 INTRODUCTION

In keeping with its responsibility to manage the UK’s National Telephone Numbering Plan efficiently, Ofcom seeks to base both tactical and strategic changes to the Plan on sound evidence. Specific to this study, measures designed to ensure that sufficient numbering is available should be both practical for operators and free from side effects.

To rectify the likely shortage of geographic numbers in some parts of the UK, a recent consultation on the allocation of numbers to operators[1] proposed the extension of the established 'conservation areas'. Implementation of this proposal entails the allocation of smaller number blocks (in this instance, 1k instead of 10k). The aim of this change is to promote more efficient use of the limited ranges that are available. However, there is a cost of working with smaller number blocks, this being that a finer analysis has to be carried out to decode the destination of a given number. This means that more resource has to be used to establish the correct routing for a call.

Ofcom understands that certain parts of the Public Switched Telephone Network have a finite decode capacity that cannot readily be increased. The extent to which this might limit the implementation of smaller number block allocation needs to be fully understood and any significant obstacles and/or risk factors identified. In order to find the technical detail needed to inform policy in this area, Ofcom have commissioned Intercai Mondiale to gather, test and analyse relevant information from operators. This document reports on this work.

1.1 Specific objectives

There are three separate objectives behind the overall aim of qualifying the practicality of allocating smaller number blocks:

- For Geographic numbering, to assess the feasibility of routing calls if number blocks are allocated in units of 1k rather than the current practice of 10k.

- For Mobile numbering, to assess the feasibility of routing calls if number blocks are allocated in units of 100k rather than 1 million numbers.

- For Non-Geographic (i.e. 08 and 09 Special Service numbers), to assess the feasibility of routing calls if number blocks are allocated in units of 1k rather than 10k (as is currently the case).

In each instance, the intent in this report is to explain, primarily at a technical level, the key issues that face operators. At the same time, an assessment is made of the commercial and practical viability of carrying out the finer digit analysis that is required when smaller number blocks are allocated. In the case of geographic number, the extent to which number conservation can be implemented is made. A similar assessment, as far as possible, is made for the issuing of non-geographic numbers in smaller blocks. For Mobile numbers, the issue is less one of technical feasibility, more one of inter-network operation. In this case, the aim is to identify any 'drop dead' issue that would stop the issue of mobile numbers in 100k blocks.

A set of questions on digit analysis, signalling and routing was prepared as a basis for establishing factual information and this was copied to a number of the leading operators (both fixed and mobile). Subsequent meetings were set up to analyse and challenge the information provided at the same time as discussing practical and commercial implications.

1.2 Contents of Report

The report is set out to answer each of the three main questions in turn. To set the scene for changing number arrangements, the next section gives a brief resume of the way in which the UK's National Telephone Numbering Plan has evolved over the last few years. Following this

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[1] *Conserving geographic numbers: proposals for geographic number conservation measures*

background, there is a section that explains the key issues in data decode, as this is fundamental to all instances of smaller number block allocations.

The following three sections address, in turn, Geographic, Mobile and Non-Geographic numbering. Each of these sections has a common structure. First, the technical findings and salient facts are detailed. This is followed by a consideration of implementation issues and any fundamental limits that apply. To complete the section, the likely implications on policy are discussed.

In the course of this investigation, issues that don't directly impact finer digit analysis but that are generally relevant to numbering have arisen. Section 7 deals with a specific instance – the limits on destination categories in System X.

The next three sections deal with topics that have not been examined in great depth on this occasion but that are inevitable pieces of the wider picture. These are, respectively, the influence that the soon to be implemented next generation network technology will have on numbering, the likely impact of finer digit analysis on the Information Systems that support network operations and personnel issues relating to the administration of data decode.

To complete the report, an overall assessment is given in Section 11. This discusses all of the information presented with regard to the full breadth of practical, technical and commercial considerations. In particular, this section considers other regulatory measures and how they interact with the specific issue of number conservation.

Technical details of number analysis for routing (both for System X and AXE) is given in the appendices, as well as a description of mobile numbering. Details of the operators consulted in this study are also included.

2 BACKGROUND TO NUMBERING DEVELOPMENTS

The issue of finer digit analysis flows from the history of the evolution of the UK telephone numbering plan. Since the 1980s, the UK has transformed its number plan from a 10 digit to an 11 digit scheme, thereby providing copious capacity for the growth in demand for telephone numbers in our major towns and cities as well as scope for many new non-geographic services which are at the heart of the competitive telecoms market. The key dates were:

6th May 1990: London changes from 01 to 071/081, doubling the capacity and releasing the 01 level.

16th April 1995: PhOne Day – geographic codes are prefixed by 1, thereby releasing levels 02-09 for later use. 5 cities are given immediate relief using codes 011x, with Reading following soon after.

22nd April 2000: The Big Number change – non-geographic codes are moved to new levels 07, 08 and 09, while 5 cities plus Northern Ireland are migrated from 01 to 02 'wide area' codes.

An important feature of the new numbering plan is that area codes are only moved from 01 to 02 when demand justifies it, thereby minimising the cost and inconvenience associated with number changes.

After the final changes in 2000, it became evident that further area codes might need relief in the medium term. It was considered undesirable to change individual areas as had happened with Reading in 1996, but to organise changes in groups when publicity and public education could be better focussed. It was therefore decided to take steps to avoid premature changes in the early 2000s by introducing conservation measures in a small number of area codes. In 9 areas, numbers would henceforth be allocated in blocks of 1000 instead of 10k, while in a further 11 areas, blocks would continue to be allocated in 10k blocks but operators being required to exploit only 1000 at a time.

These conservation measures have been very successful in slowing the consumption of numbers, so much so that no further 01 to 02 migrations have been programmed. However, the emergence of new Voice over IP services has created a completely new problem. These services ride over existing broadband access lines and therefore they can be offered anywhere where broadband is available – which is now most of the country. VoIP providers have the choice of either geographic numbers or the 056 number range for ‘nomadic services’, but many prefer geographic numbers. Not being held back by investment in local loop plant, many VoIP providers have emerged and made requests for number allocations across almost all UK number ranges. This has meant that many areas not even considered as being on the ‘watch list’, let alone having conservation status, now appear to have limited available numbering capacity.

Ofcom now faces a set of decisions. It could expand the Type A conservation area list to around 44 or more areas with implications for call routeing, or carry out the pre-planned migration to an 02 area which would eliminate the shortage. The difficulty with the latter option is that the final 02/03 option is not yet settled and would need to be before any further 02 migrations are performed. Furthermore, any 01 to 02 change would affect all the customers in that area in terms of cost and inconvenience, while the benefits would accrue to a relatively small number of customers and VoIP operators. In some cases, the VoIP customer might not even live in the area concerned: many might desire a number in an attractive business location, while actually being located elsewhere.

Key to deciding which policy to adopt is to understand the limitations that present day exchange technology has with 1k block routing. At the same time, given that number analysis uses a common decode resource, Ofcom wishes to understand the technical limitations in finer digit analysis in the mobile and non-geographic codes.

3 DATA DECODE – GENERAL FINDINGS

At the core of each of the specific objectives in this study is the ability of current telecommunications equipment to decode numbers and thereby determine the correct treatment for a call. This section sets out the facts and issues, based on direct feedback from operators.

3.1 Outline of investigations

The information gathering phase of this project comprised meetings with fixed and mobile operators, for which the ground was prepared by providing a detailed questionnaire of specific points to be explored. One operator provided a detailed written response in lieu of a meeting, while another suggested that finer digit analysis would not raise any issue for them. The study also comprised desk research and some less formal (non-attributable) telephone interviews, face to face conversations and e-mail exchanges. The latter included some smaller operators, equipment vendors and industry bodies. This allowed for the collection of detailed material from the operators, corroboration of findings and an ability for check and peer review.

Aside from a few minor (usually operator specific) issues, there was a good deal of consistency in the information gleaned and a strong consensus about the issue of finer digit analysis.

3.2 Main findings

All current generation telephone exchanges possess a finite capacity for digit analysis. This is not determined by the capacity of the processors or their memory and these are not found to be limiting factors in practice. Rather the architecture for addressing the decode chains usually has a specific limit. Given the legacy nature of today’s systems, it is not considered practical to expand these, so numbering policy must be mindful of this issue. There are limits to the depth of digit analysis but this is rarely a limiting factor. The finite capacity is expressed in either data decode blocks or data decode lines according to the particular system used. The system of decode does differ between, say, Marconi's System X and Ericsson's AXE and their capacity is affected in different ways by the requirements for finer digit analysis. The way that these systems work in this regard is described in Appendices 2-4.

Network architecture and switch function both have an effect on decode requirements. Local exchanges have to do the final decode of the subscriber number, which consumes significant capacity, although some systems use a separate decode field for the last part of this. Local exchanges tend to have limited connectivity compared to transit exchanges, which are frequently part of a large mesh. This might be thought to mean that local exchanges would have a lower requirement for data decode than transit exchanges, which frequently have to be able to decode the entire numbering plan. In some networks (e.g. small Altnets) this is certainly true, but in BT's and some other large networks it is the local exchange that has the largest requirement for data decode. This is driven by a range of reasons. These include the need, in BT's case, to support legacy on-switch charging, number length determination, multiple-parenting on DMSUs and the special requirements of Carrier Pre-Selection (CPS). The latter includes the decoding of CPS categories (National, International and All Calls) and more recently the special routing requirements to support the Same/Adjacent DLE (SAD) facility (explained in Section 4.1).

There are geographic variations in the decode utilisation of BT's local exchanges across the country. Major cities which have extensive DLE-DLE interconnection and competitive entry by CPS operators at the local exchange level are the most constrained, although the pattern is by no means straightforward. None of the Altnets have such extensive requirements for decode as BT. They do not perform on-switch charging and have no obligations for CPS, for example. Furthermore, their network connectivity is often much simpler than BT's and many calls which are routed to BT do not require the same depth of analysis as BT has to perform. However, larger Altnets that provide transit services do face comparable levels of complexity. Some Altnet's local exchanges also double up with a tandem function.

For BT's local exchanges, the AXE system is more constrained than System X, since finer digit analysis is likely to consume resources faster than for System X. The amount of resources still available should provide for the expansion of geographic conservation measures if required, but would be consuming resources that might be needed for other market and regulatory developments, for example in the non-geographic ranges. The overall impact of finer digit analysis is therefore a complex one, determined by the current utilisation of resource and the type of decode required.

It was notable that many reasons for increases in digit decode capacity were 'externalities' as far as most operators are concerned, e.g. 1k routing in 0800, introduction of CPS, growth in non-geo price points, growth in number of operators. In each case, the operators have to cope with a demand on a resource over which they feel they have no control.

4 GEOGRAPHIC NUMBERS

4.1 Technical findings

As explained in the Appendices, System X and AXE use slightly different methods for decoding numbers and this means that the impact of 1k routing is different. In the BT network, the most constrained System X DLE has around 11k blocks spare, while the most loaded AXE has around 16k lines spare. If 50 conservation areas were created and in each one the initial 1k allocations are kept within one 10k block and supposing that, say, 6 blocks in each area were allocated, then System X would need to take into use 50 extra blocks, while AXE would use another 350 lines of decode. If no other number blocks were allocated by Ofcom, then one could create 50 new conservation areas each year and after 10 years the next extra loading from the *initial* allocations would be 500 blocks on System X and 3500 lines on AXE. Put that way, there really isn't a problem with creating conservation areas, although this would alone consume 22% of the spare space in AXE. But in practice, the early conservation areas would be progressively opening up new 10k blocks, which would further increase utilisation. However, the biggest problem with this analysis is that it assumes nothing else is happening in the number plan, which is clearly unrealistic.

The findings here are based on a good deal of quantified information received from BT and others. To an extent, however, looking at averages won't pick up the particular pinch-points which would in practice form the key limiting factors. The study did look in detail at some of the highest loaded exchanges, but found significant variation from the norm, reflecting the individual situation at a given exchange. So while the average utilisations can be influenced by allocation policies, the practical limitations will be driven by both these policies and the individual conditions at each exchange, largely driven by its connectivity within its own network and with other operators.

However, the following broad observations can be made concerning BT's network:

- DMSUs have a quite different mix of decode utilisation, since each switch has to decode all geographic ranges down to 10k/1k to determine routing. In contrast, a DLE will only tend to decode geographic codes down the area code level, except for its own local interconnections. However, DMSUs' overall decode utilisation is usually not above 36% - they have no local subscribers - so they are unlikely to cause problems for finer digit analysis.

- The amount of DLE geographic decode will vary considerably. A provincial town only needs to decode 020 to route to London, whereas an exchange closer to London, or in London, is likely to have to decode every 020 xxxx code to determine which London tandem or local exchange to route to.

- The majority of System X blocks are consumed by local subscriber decode. In contrast AXE does the decode of the final hundred blocks in separate fields.

- The most loaded System X DLEs have a block utilisation of around 67% and the most loaded AXE's have a line utilisation of around 50%. It is important to understand the difference between blocks and lines to appreciate that nevertheless, this means that AXE is actually the more constrained. In the last decade to be decoded, one System X block is equivalent to 10 AXE lines.

- Over 50% of AXE utilisation is from the non-geo 08/09 ranges, reflecting the fact that irrespective of geography, all non-geo codes have to be decoded down to the 10k/1k level to ensure the right DMSU route(s) are selected to reach the right Altnet point of interconnection, or in the case of BT's own blocks, to trigger the Intelligent Network (IN) translation. This high level of non-geo utilisation is caused by the many operators and differing price points combined with the existing policy to allocate blocks in the 0800 range at the 1k level.

- Level 1 codes (e.g. indirect access and the more recent DQ codes) are also significant and can often consume up to 10% of the capacity.

- In order to automate some parts of loading the decode tables, BT has an area of decode in System X specially allocated to work with this process.

The loading of local exchange decode has significantly increased in recent years. At first sight, local decode ought to be simple as only a few codes are routed on a limited number of side routes with most calls being sent up the DMSU level. In practice however, decode has to go much deeper than that in order to determine charging, which is generally at the Area Code level for geographic calls, at the 100k level for non-geographic and the 1M level for mobile. Although customer billing has been performed ‘off-switch’ since 1995, the on-switch charging is still required to support payphone pulsing, subscriber private metering (still used extensively by hotels and others) and the Advice of Duration and Charge service. Since there are only 64 charge bands on the switch, many newer price points are subject to approximation.

For non-geo codes, however, decode will generally have to go right down to the operator specific level, as the choice of DMSU routing(s) will vary by operator. The implementation of FRIACO caused several operators to introduce DLE interconnect with BT and this has led to demands to exploit these routes for other non-geo traffic destined for that network.

The introduction of CPS added some further complexity as the decode has to be broken at the point where one can establish the CPS categories of National and International and this is then combined with the Customer’s CPS option to determine the routing. However, a more significant level of complexity was introduced with the SAD options on CPS. The Same/Adjacent DLE feature means that BT routes certain CPS calls to such exchanges solely on its network rather than tromboning it via the CPS operator’s network. This has further increased decode complexity for several reasons:

- Generally, it has further incentivised DLE interconnect so that many non-geo codes belonging to the Altnet concerned are now required to route over their local interconnect in order to utilise their network as much as possible. All such routings will vary by Altnet concerned, but this is achieved on the whole by analysis after the existing digit decode;

- The SAD feature itself requires that CPS routing is overridden for calls to the same and adjacent DLEs but only for CPS operators using this feature. Again, this adds complexity of analysis, though does not of itself increase the digit decode part.

- CPS/SAD operators expect all calls to SAD exchanges to be carried by BT with non-SAD traffic sent over their local interconnect. However, until recently, BT routed some of its own calls to SAD exchanges via the DMSU to simplify digit analysis. These are ‘migrated’ Featurenet numbers hosted on adjacent DLEs which were sent to the DMSU so that the more complex decode of these 100 and 1k customer blocks was only done there. But now BT feels that it has to do the full decode at each DLE in order that SAD/CPS operators get all SAD calls handled correctly. The same problem occurs with PSTN numbers migrated to Featurenet. (This migration can be thought of as similar to ‘block-porting’ but between different platforms within the BT network). This extra decode of 1k and 100 number blocks has led to a real increase in consumption of digit decode resources. Analysing blocks at the 100 level requires AXE (which is limited to 8 digits for decode) to utilise extra points of entry.

BT raised a particular concern that decode would quickly exhaust if Altnets asked for their own geographic blocks to be routed over their local DLE interconnects. This would require far deeper analysis within area codes than is presently done. However, the decision on the point of handover for geographic calls should rest with the originating network, so such requests ought to be ‘unreasonable’. In any event, as the Altnet would only get the reciprocal terminating fee for such calls, there would be no real incentive to carry such traffic.

4.2 Implementation and limitation issues

The actual implementation of extra geographic 1k blocks is not thought to create any significant implementation issues. 1k routing is already performed in some conservation areas, the 0800 range and FRIACO ranges. The issue is not one of technical capability but capacity, for both system and personnel resources.

It would appear that the level of code conservation currently proposed can be accommodated within the UK networks, but if there is indefinite expansion then there is potential for some difficulties. Once allocated at the 1k level, the extra decode resource is committed even if a subsequent migration to 02 occurs (assuming that wholesale customer renumbering is highly undesirable). Since the decode resource is common to all types of number, this is likely to be felt most where new services requiring new block allocations emerge. So for example, if the 056 number range for nomadic VoIP were to take off in a big way, this could consume a large amount of decode space. Similarly if more non-geo price points are introduced (e.g. PRS above £1.50 per min) then this is likely to bring much greater pressure on capacity.

4.3 Implications for numbering policy

We recognise that the problems of finer digit analysis would be avoided if the present finite decode limits could be expanded. However, given that today's systems are now considered to be 'legacy technology' because of the imminent arrival of Next Generation Networks, it is considered impractical to make such fundamental changes to the basic switch architecture. The technical and personnel resources for such a change are unlikely to be available in either vendors or the operators, and the commercial relationships between them are now restricted to minor maintenance issues only.

Finer digit analysis at the 1k block level clearly adds complexity to network routing and consumes more of the finite digit decode capacity. Conservation measures were originally introduced to delay code migrations from 01 to 02 until convenient. If and when a code is subsequently migrated to 02, new allocations at the 10k level could then restart, but the 1k blocks already allocated will still remain within the new 02 structure. 1k block allocations are therefore cumulative and do not disappear when code migration occurs. A policy of continuing to rely on creating ever more conservation areas may therefore not be wise, especially if pressures from other parts of the numbering scheme arise. We will return to this issue below when the non-geographic codes are considered.

It may be useful for Ofcom to confirm with the operators, and especially BT, that geographic number handover is determined by the originating network and that BT should not therefore face requests to route Altnet geographic codes over DLE interconnects.

5 MOBILE NUMBERS

5.1 Technical findings

Given that fixed networks already use block allocations at the 10k level, moving mobile numbers from 1M blocks to 100k blocks is not likely to impact the basic routing of mobile calls in the UK. However, unlike fixed networks, mobile networks use two different numbering schemes. Internally, they use the E.212 International Mobile Subscriber Identification (IMSI) plan, while externally they use the E.164 plan, the ordinary numbers that customers dial. The mix of these two systems creates a requirement for some translation (called Global Title Translation) between the two types of number and such translation will need to take into account any increased granularity in the digits needed to identify a given GSM network. An outline of how mobile networks use numbers can be found at Appendix 5.

The particular scenarios where the extra granularity would need to be accommodated are:

- At incoming international SCCP gateways, where the E.164 addressed messages need to be delivered to the right mobile network (in practice we found that almost all SCCP routings looked at the full E.164 code, as the system of communicating codes is a global one);

- In overseas GSM networks which need to decode the E.164 numbers on UK-bound text messages in order to select the right SCCP routing to the destination network;

- In overseas GSM networks that have implemented ‘Optimal Routing’. This is where calls between roaming mobiles are routed efficiently without tromboning via the calling mobile’s home network. It is optional and not thought to be widely deployed at present, if at all.

All the operators interviewed made similar points about 100k routing. It would increase the consumption of decode blocks both for circuit switched routing and for SCCP routing, although there appears to be no imminent risk of either of these decode resources becoming exhausted – current utilisations are usually in the 20-30% range. Indeed, for circuit switched decode, the need to decode UK fixed codes still consumes more decode space on mobile networks than the mobile codes themselves. (Typically, a mobile network will decode fixed area codes, so as to handover calls to BT on a ‘least cost’ basis). 100k blocks would add to the complexity of digit decode leading to a greater risk of errors leading to misroutes, especially as such codings need to be promulgated to all GSM networks across the globe. However, given that BT decode to much greater depth for fixed calls without there being evidence of a significant level of errors, it is hard to see this as a major issue. One mobile network reported that it didn’t actually check the decode trees it implements and perhaps it should.

The SCCP decodes present a more complex picture since overseas networks are involved and their capabilities cannot be confirmed. However we found several countries already using numbering schemes that require the same analysis down to the 7th digit as 100k blocks in the UK 44 area would imply. The most readily illustrated examples are Russia (7 901 192xxxx allocated to Vlad telecom, 7 901 194xxxx allocated to Yartelecom) and Japan (81 90364xxxx allocated to Tohoku, 81 90365xxxx allocated to Kansai). A yet finer allocation is evident in Iran (98 9111 22 allocated to Amol, 98 9111 23 allocated to Qaem Shahr). Japan changed to their current numbering arrangement in 1999 and Iran in 2004.

In addition to these, a number of South American countries have mobile operators behind geographic number ranges. These have been cited by several of the UK mobile operators as the most demanding with which to maintain roaming agreements.

ITU Recommendation E.162 calls for international traffic to be subject to analysis down to the 7th digit, which for the UK corresponds to a 100k block. The SCCP decode tables used for this function are not excessively utilised by UK operators (including BT as an SCCP gateway operator) and this suggests that worldwide, there is unlikely to be a problem with either depth of decode for 100k, or incremental decode capability. However, there are some risks and neither UK operators nor Ofcom have the ability to insist on the technical capabilities of overseas networks, so some risks remain that in practice not all overseas GSM networks could cope. Some support systems may be less flexible than the switching equipment itself and it is nearly impossible to ascertain their capabilities across all the world’s GSM networks.

None of the mobile networks interviewed had implemented Optimal Routing, as its complexity was seen to outweigh the advantages. However, in the area of number portability, there is a trend to implement forms of Optimal Routing within the UK:

- Call Trapping – designed to avoid tromboning out to another network and back if the ported number is on one’s home network;

- Call Trapping Plus – designed to identify the location of all ported numbers so as to avoid tromboning on all calls to ported numbers.

These call trapping functions require analysis of more UK mobile number ranges in order to identify the relevant HLR where the network ownership of a ported number can be established. This requires a greater depth of analysis compared than that required simply to identify the network to route the call to. However, it is not clear that 100k routing would add to the complexity of this trapping function. Many operators already spread their customers over their HLRs in blocks of 100k or even 10k.

Another strong and consistent theme from the mobile operators is that despite their work to recycle numbers as efficiently as possible, the general churn rate and underlying growth means that most networks need an extra 4-6 blocks of 1million numbers each year. Given that the networks believe they are efficiently utilising these 1M blocks, it makes no sense to impose 100k blocks on them. This would not only lead to a tenfold increase in administrative work, but would potentially add decode complexity where it is not necessary. Therefore, if 100k allocation is justified in some cases, it should be applied not in a blind 'non-discriminatory' way to everyone, but in a proportionate way when objectively justified.

5.2 International Roaming

On roaming calls, there is a need to access the Home Location Register and a hybrid E.214 number is used for this in order to route from the overseas network via SCCP to the HLR. This hybrid number is formed of the country code 44, a 3 or 4 digit area code and the 10 digits of the IMSI handset number formed by removing the E.212 country code and Mobile Network Code. When these lookups reach the UK network, they are used to access the right HLR. In practice, each mobile network only needs one such code. Some operators use the pre-Code Change 3 digit area code (eg 385 for Vodafone) while T-Mobile use the post Code Change 7953. Some operators opted to stay with the 3 digit codes because some SIM cards had the SMSC address 'burnt in' with the pre-code change codes or because they cannot cope with the implications of a 4 digit code. Since E.164 numbers are a maximum of 15 digits, if a code of the form 447xxx is used, then the last digit of the 10 digit handset number has to be truncated. If 100k blocks were assigned to *new* GSM networks, then an appropriate code would need to be allocated for these purposes, but it could be any code that doesn't clash with the existing codes, so the extra digit depth need not cause problems. This is a completely self-contained numbering scheme.

5.3 Implementation and limitation issues

The changes in UK codes are promulgated to all other GSM operators via the IR21 process. In the main, changes are grouped and transmitted every three months, so as to ensure that each set is implemented before another is dispatched. Therefore, from allocation to full worldwide implementation can take up to 6 months.

Although the decode for both circuit switched and SCCP messages have finite limits, we conclude that the introduction of 100k block routing will not raise any issues about limited capacity in the networks, although supporting operational systems may require changes, for example, if they perform 'sanity checks' for code length on UK mobile area codes.

5.4 Implications for numbering policy

It remains unclear what the major driver is for 100k block allocation. There is not only considerable space in the 077/8/9 ranges but 071-075 remain unused, which alone represents 500 1M blocks.

Before allocating in 100k blocks, it might be prudent to notify all countries via the ITU that the UK's mobile number plan was moving from a 4 digit plan to a mixed 4/5 digit plan, giving 2 years notice as was the case for the 2000 number change when the UK mobiles moved from the 3 to 4 digit plan. This is because some countries might reject codes that appear to be the wrong length.

It remains the view of mobile network operators that service providers should normally seek their number allocations from the underlying network operators. They tend to sub-allocate in 100k blocks, so if they were forced themselves to acquire in 100k blocks, they would have to pass on the entire block – few service providers would accept a smaller unit of allocation. Only where providers (e.g. MVNOs) are implementing their own network functions should separate number blocks be allocated to them. While some MVNOs might not justify 1M blocks of numbers, it was felt that Ofcom should continue to challenge such operators to ensure that whatever network architecture they proposed to use would utilise numbers efficiently.

6 NON-GEOGRAPHIC NUMBERS

6.1 Technical findings

The technical issues for non-geographic numbers are very similar to that for geographic but there are some differences. In the 0800 range, some numbers are 6 digit and some 7. New number blocks are already given only at the 1k level, so analysis of 7 digits is necessary to determine routing and number length. In the other ranges, the increasing number of both providers and price points has led to a significant quantity of codes being allocated with make the non-geo ranges very consuming of decode resources.

6.2 Implementation and limitation issues

Given that some 1k routing already exists in the non-geo ranges, we would not expect any specific implementation issues to arise. As with geographic, it is not one of capability, but scale.

One of the reasons for growth in non-geographic block requests in recent years has been the need to open new charge points and these have to date been at the 100k level. Opening up more 1k levels raises similar issues to that on geographic codes, except that it might, because of the charging issue, mean several levels being sub-divided for 1k routing at any given time.

Suppose for example that PRS is opened up above £1.50 per minute to a maximum of £5. Assume that for maximum market flexibility, price points are introduced in 25p steps and that half of the present non-geo operators (i.e. about 100) opt to take a 1k block in each price point. This would consume some 140 extra decode blocks in System X (or more if operators were given the choice of code) and 1540 extra decode lines in AXE. But it could be three times more than this if all these levels were opened up for single drop charge, as well by duration and also for Sexual Entertainment Services. As with the geographic numbers, if nothing else was occurring then such an addition could be accommodated. But of course, it may well be that pressure will also mount to introduce more price points within the 084 and 087 ranges. So it is easy to see that the spare capacity in AXE could be significantly impacted by developments in policy for non-geographic ranges.

Another area which could expand from its current low base is the 056 range for nomadic VoIP. Because of the very different business models in this market, we might expect to see a multiplicity of price points and operators.

6.3 Implications for policy

When the present numbering plan was designed, a very generous allocation was made for non-geo services in 07, 08 and 09 – representing a theoretical maximum of 3 billion numbers (3 x10^9). With geographic ranges, efficiency is constrained by geographic modularity, the number of operators and the retention of the open number plan, i.e. two part dialling. Non-geographic ranges don't suffer from the geographic modularity or the dialling constraints. But they do suffer inefficiency caused by allocations to many operators at many separate price points. Market entry in non-geo services is far less constrained than in fixed and some 200 operators exist. Given the overall size of the non-geo ranges, there is not likely to be any overall exhaustion, but it does point to the need to make the block allocation size, presently 10k (with charging significance at the 100k level), more flexible to ensure that efficiency is kept within reasonable bounds. High block utilisation is not of itself a virtue. It was always the thought that the 11 digit numbering scheme would provide a plan where overall efficiency was bound to be low but where it could flex to a wide range of possible market scenarios, e.g. everyone migrates to a mobile number or a personal number, everyone might want to rent a freephone number, lots of phones having 2 numbers etc.

In order to safeguard the further development of the non-geographic services, it would therefore seem prudent to extend 1k block routing where justified for small operators with many price points, but in order not to impose administrative inefficiency on larger operators, to continue to allocate 10k blocks where justified. However, opening up lots of new price points could cause a significant impact on the available decode resource, so a full impact analysis should be done on any such proposal.

Market development is not though under Ofcom's control, whereas the migration of fixed number groups from 01 to 02 is. Therefore, there is an argument that 02 migration would be sensible in order to maximise the decode resources that operators may need to cope with non-geo developments.

7 DESTINATION CATEGORIES IN SYSTEM X

So far we have considered the digit decode resources of blocks and lines. However, there is another hard limit in System X that could bring difficulties. Once the number decoding is completed, the outlet of the tree points to a specific Destination Category, otherwise known as a Routing Category. This defines all the parameters concerning the handling of the call and separate categories are needed for differing routes, operators, price points and other routing issues. System X has a fixed limit of 4096 such categories and on some exchanges they are already 82% utilised. Increases in routing complexity brought about by DLE interconnects, more operators and more price points will increase demands for these categories and we are of the opinion that this represents a more imminent issue in terms of exhaustion than digit decode. Further, these categories are consumed whether the new number ranges are allocated at the 10k or 1k levels.

In the short time available for this project we have not been able to explore this issue in detail. The precise rules for category allocation are not known and some 'claw-back' of categories may be possible. We recommend that further work is undertaken in this area to attempt to ensure that this does not become a brake on market innovation.

8 IMPACT OF NEXT GENERATION NETWORK TECHNOLOGY

On the face of it, many of the current problems with number/routing go away with next generation networks. Feedback from vendors suggests that systems will be designed without the present finite decode limits. However, there are practical issues of gateway translation that mean that the existing number structure and attendant problems will persist.

It would be a mistake to believe that in the Next Generation world, all routing is done at the IP level. In reality, telephone numbers will be translated to IP addresses for routing within a given operator's network, in a similar manner to the way that mobile numbers are translated to mobile roaming numbers in a GSM network. But for calls destined for other operators networks, it is likely that even in a fully IP world, the interconnect signalling will use SIP-I, which is in principle traditional C7 signalling (with E.164 numbers) encapsulated within a SIP format. Operators will want to keep their IP networks secure from malign attacks so that one network's IP addresses will not be visible to another's. The exception to this might be for Internet Telephony operators who might see an advantage in keeping calls connected via the Internet rather than being handed back to the circuit switched world. Technologies such as 'Infrastructure ENUM' might play a role in this.

So most calls passing across interconnects to other operators will be analysed by the number blocks allocated by Ofcom just as now. However, many believe that some types of call will be routed more efficiently. For example, the present onward routing system for number portability could be replaced, not by a centralised IN database as some countries use already in the circuit switched world, but by a distributed number database akin to the distributed Domain Name System used in the Internet. Using 'look ahead' techniques, signals could be passed back allowing efficient routing of ported calls. The present 'DLE drop-back and reroute' used within BT's network is a present day example of such an idea, but in future it could work across different operators' networks.

The other key point about NGNs is that because the call control is completely separated from the routing, digit decode will take place in servers distant from the network routers. The present burden of maintaining bespoke decode trees in hundreds of network processors will disappear and the impact of human error will decrease.

There could of course be some added complexity during the period when NGNs and the current circuit switched network co-exist, in a similar manner to that which occurred in the 1980/90s when analogue networks co-existed with digital. However, feedback suggests that this should not result in any extra pressure on the existing decode resource in the existing network.

9 INFORMATION SYSTEMS

This project was confined to analysing the routing implications of finer digit analysis. Nevertheless, it became clear during the project that while there seemed to be few direct and immediate network limitations to finer digit analysis, the increased burden of digit analysis would have knock on impact in other areas, especially operational support systems that relate to the numbering plan.

In the GSM networks, while finer digit analysis down to 7 digits probably poses no network problems, there may well be in some overseas networks systems that assume, based on earlier notifications, that the UK mobile network numbering plan is always 447xxx to identify a particular network.

In BT, there are around 25 separate information systems that, while capable of handling 1k number blocks that already exist, may come under capacity pressure if this concept is more widely adopted.

10 PERSONNEL ISSUES

Another theme frequently expressed by all operators was the problem of the personnel pressures that finer digit decode might imply. Data decode is a specialist field of work and operators are reluctant to expand this on a legacy technology where they might soon find the staff surplus to their needs. One large Altnet reports that its databuild function is already working at breaking point because of the recent entry of so many new operators, both non-geo and VoIP. We have also alluded above to concerns about human error.

While we accept the validity of these concerns, we form the view that they are not driven specifically by finer digit analysis, but by the need to provide decode table entries for these operators and their codes and that this would be of much the same load whether the blocks were at the 10k or 1k level (and in mobile similarly be they 1M or 100k). The overall market growth creates externally imposed loads on their systems and personnel. But the usual wisdom is that consumers are the overall winners where such competitive growth emerges.

11 OVERALL ASSESSMENT OF THE VIABILITY OF FINER DIGIT ANALYSIS

Based on the information received from operators and vendors, we have established the finite limits that currently exist in the various telecoms networks. We have identified the degree of utilisation of digit decode resources and the drivers underlying its increased consumption.

While we believe that it is unlikely that these finite limits could be redeveloped, given the legacy nature of the present exchange systems, we have not identified any single initiative connected with finer digit analysis that would on its own create difficulties. We are convinced that the only real challenges rest with the BT network and possibly some of the larger transit Altnets. But BT alone is subject to regulatory requirements, various legacy arrangements and also being the default router of all calls.

The continuing growth in complexity within the non-geographic ranges gives some cause for concern. The difference between the non-geo and geo ranges is that it is normally the case that Ofcom consult on the introduction of new conservation areas, whereas new operators and price points tend to be introduced ‘on demand’. As we have seen, other increases in recent years have their origins in regulatory developments, such as the introduction of FRIACO, CPS (including, in particular, SAD), the imposition of 1k routing in 0800 and the other regulatory incentives to introduce DLE interconnect. In conjunction with this, the industry remains unclear as to Ofcom’s future policy in the numbering area and so tends to react with caution to proposals to introduce finer digit analysis. Additionally, all operators still implement decode changes in ways that rely on human accuracy and there remain significant concerns about greater errors being made if the numbering scheme is made more complex. Ironically, where BT has automated some parts of this process to reduce human intervention, this itself consumes some decode capacity.

There remains broad support for the numbering plan that was introduced during the 1990s and that ultimately the transition to wide area geographic codes represents a better approach than trying to use conservation measures, which were designed as stop-gap measure, as a permanent solution to numbering growth. It should be noted that a majority of UK customers now have 02 numbers, compared to those with 01.

In the mobile area, the 07 range has plenty of unallocated capacity and room to expand into the 071-075 levels, so it is difficult to see that a move away from 1M allocations is really driven by any real scarcity of capacity.

While it is separate from the issue of finer digit analysis, we have concerns about the issue of System X destination categories and believe that further work should be carried out on this topic.

12 CONCLUSION

This study has provided a technical assessment of the viability of finer digit analysis as a means of conserving numbers. The main finding is that there are few immediate limitations to the implementation of any particular scheme for this. A detailed analysis of the degree to which resources are consumed at present and the extent to which they could be stretched is given in the body of the report. Despite the absence of a hard technical limit on finer digit analysis, the industry remains concerned that the utilisation of decode resources are outside their direct control and therefore they are bound to adopt a precautionary stance.

The main reason for this is that the conservation measure of allocating smaller number blocks is not insulated from other regulatory measures. There are a variety of calls on the finite decode resource installed in established networks and an increase in demand in one area (for instance, extensive adoption of the 056 number range for nomadic voice over IP) could quickly compromise the extent to which finer digit analysis could be carried out.

In view of the competing demands for decode resource, a regular audit of the cumulative effects of regulation would provide a sound basis for overall policy.

The above logic does not concern mobile networks in the same way. In this instance the balance that needs to be considered is between the additional administration needed with smaller number blocks and the demand for conservation in the light of plentiful reserve of numbers. It is not clear that there will be significant demands on this reserve.

We believe that while numbering will always ultimately represent a finite resource, the 11 digit UK numbering scheme, as introduced during the 1995-2000 timeframe, provides a plan which does not need to be viewed as being a scarce resource. A move to finer digit analysis may provide some temporary respite to number changes, but at the same time it means the adoption of a system of micro-management of the numbering plan which is counter to the underlying theme of regulatory withdrawal.

A final observation on the allocation of smaller number blocks is that adds permanent complexity. Whatever changes are subsequently made the requirement to route on finer digit analysis remains and the decode resource thereby consumed is unavailable for any other use.

Glossary

Altnet	An Alternative, i.e. non-BT Network, previously referred to as Other Licensed Operators (OLOs).
CPS	Carrier Pre-Selection, a facility that allows customers to buy their calls from a different operator without having to dial extra digits before the number or change their phone line.
DLE	Digital Local Exchange, the point of customer connection to the telephone network, often via a concentrator
DMSU	Digital Main Switching Unit, the trunk exchange primarily used for connecting long distance calls.
ENUM	Electronic Numbers, developed as a means of finding services on an IP-based network using a telephone number,
Featurenet	A BT service providing Centrex (i.e a virtual switchboard) and Virtual Private Networking, which uses a separate switch platform from the regular PSTN services.
FRIACO	Flat Rate Internet Access Call Origination, a BT wholesale product for unmetered access from BT customers to the local exchange.
GT	Global Title, a logical address used for routing Signalling System No. 7 (SS7) messages using signalling connection control part (SCCP) capabilities
HLR	Home Location Register, the main database of permanent subscriber information for a mobile network
IMSI	International Mobile Subscriber Identity, the unique number that is associated with all mobile phone users
IN	Intelligent Network – an architecture featuring a centralised database which assists call routing and number translation
MAP	Mobile Application Part, protocol for real time communication between nodes in a mobile cellular network, typically used to transfer information between a VLR and an HLR
MCC	Mobile Country Code, a three digit code specified by ITU Recommendation E.212
MNC	Mobile Network Code, a two or three digit code specified in ITU recommendation E.212
MSISDN	Mobile Station ISDN Number, the standard international telephone number used to identify a given mobile network subscriber
MVNO	Mobile Virtual Network Operator, a mobile operator that does not have its own network infrastructure, relying on a business arrangement with an established mobile operator to deliver service.
NGN	Next Generation Network, a packet-based network that is capable of providing a wide range of services

PRS	Premium Rate Service, a telecom service identified by a number in the 09 range and associated with a specific price.
SAD	Same/Adjacent DLE, special routing requirements required as part of CPS implementation.
SCCP	Signalling Connection Control Part, a protocol that provides a means for the transfer of messages between any two signalling points in the same or different SS7 networks.
SIM	Subscriber Identification Module, the user subscription to the mobile network. Contains relevant information that enables access onto the subscripted operator's network
SS7 C7	Both of these abbreviations refer to Signalling System No 7, the prevalent common channel signalling system defined by the ITU-T that provides a suite of protocols to enables circuit and non-circuit related information to be routed about and between networks. The main constituent parts of SS7 the Message Transfer Part (MTP), the Signalling Connection Control Part (SCCP) and the ISDN User Part (ISUP)
VLR	Visitor Location Register, contains all subscriber data required for call handling and mobility management for mobile subscribers currently located in the area controlled by the VLR
VOIP	Voice Over Internet Protocol, the carriage of voice traffic in packet format, using the Internet Protocol

A1 OPERATORS CONSULTED

The following operators were consulted in this study.

- BT
- Cable & Wireless
- Vodafone
- Orange
- T-Mobile
- NTL

Each of those listed provided substantive information that has been used in this report. The quantitative information from operators that underpins the analysis in the report is contained in a confidential annex, not issued with the main report

A draft copy of this report was circulated to a selection of these operators for comment prior to issue.

A2 Introduction to Digit Decoding

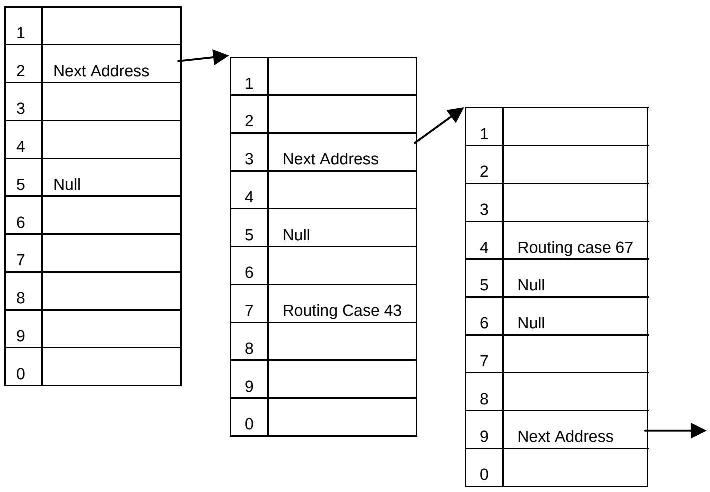
This annex gives an outline of how digit analysis operates in present generation telephone exchanges.

A fixed area of processor memory is assigned for digit analysis and within that, data decode blocks are created. There are two distinct systems found in today's switches. In the first type, fixed size blocks are employed, usually with 10 entries corresponding to the digits 1-9 and 0. Sometimes blocks may have 16 entries, allowing the decoding of digits 1-9, 0 and the extra-decimal digits used either for service codes (e.g. *, #) or international use (e.g. Code 11, Code 12 and Code 15). Each block has a result assigned for each digit level within the block. If the 'result' is null, then this represents a 'spare code' and the call will be failed with an appropriate announcement or NU tone. If the decode of this digit leads to the completion of digit analysis, then the 'result' will point to a Routeing Case, which will define the outgoing route(s) to be used, the outgoing sending programme and the call charge. If insufficient digits have yet been analysed, the 'result' will point to another decode block in the digit analysis field, where the next digit will be examined.

The fixed block system is simple to implement as all blocks are of equal size and it is easy to assign new blocks to link to existing ones. It is easy to address as the digit to be decoded is simply added to the base address of the beginning of the block. However, it is slightly wasteful of resources as space is assigned in the decades even if these levels are 'spare'.

An alternative system uses variable length blocks, where the blocks only contain the valid levels in use. This means that the resource is consumed only by the decode 'lines', not the blocks. But addressing is more complex and requires a search within the block for a match. Also, it isn't easy to add new blocks as existing ones need to be resized and extra space created. Therefore, with variable length blocks, it is usual to provide a separate area to create a new decode tree and then swap it over with the working tree.

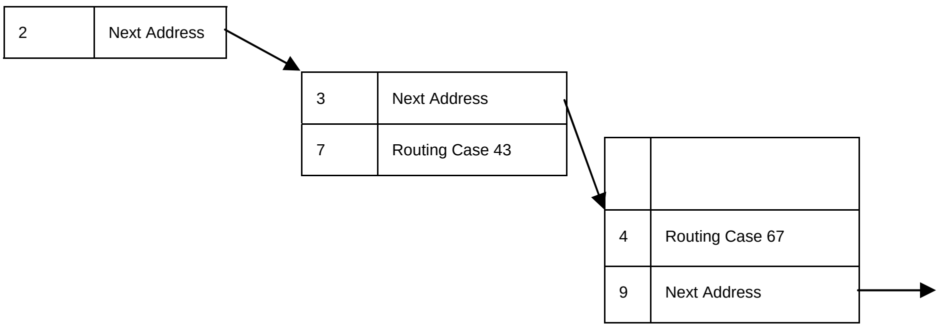
System X uses the fixed block method, while the AXE uses the variable length system. Here is an example of a fixed block decode:



In the above example, we see a hypothetical exchange decode arrangement. In the analysis of the first digit, we see that dialling 5 will be immediately recognised as a spare code. Dialling 2 leads to no immediate result. The block points to the starting address of the second block, which because of the relational addressing, can be anywhere within the digit analysis memory space. In the second block, we see that the code 27 is recognised as Routeing Case 43 and the call will be set up according to that case. Dialling 25 leads to a spare code. Dialling 23 leads to the third block being invoked. In the third block, 234 is recognised as routeing case 67, 236 is spare and 239 is taken for further analysis at the 4th level (not shown).

The important feature of this system is that only levels that require further decoding consume memory space. So, while level 239 needs further analysis at the 4th level, no blocks are assigned to the remaining 23x codes. So the memory is only consumed for levels where analysis is required. However, it does mean that more blocks are used if valid codes are spread across separated ranges, as compared to within blocks already allocated. So, in the above example, opening up level 238 would require no new blocks, whereas opening up 258 would.

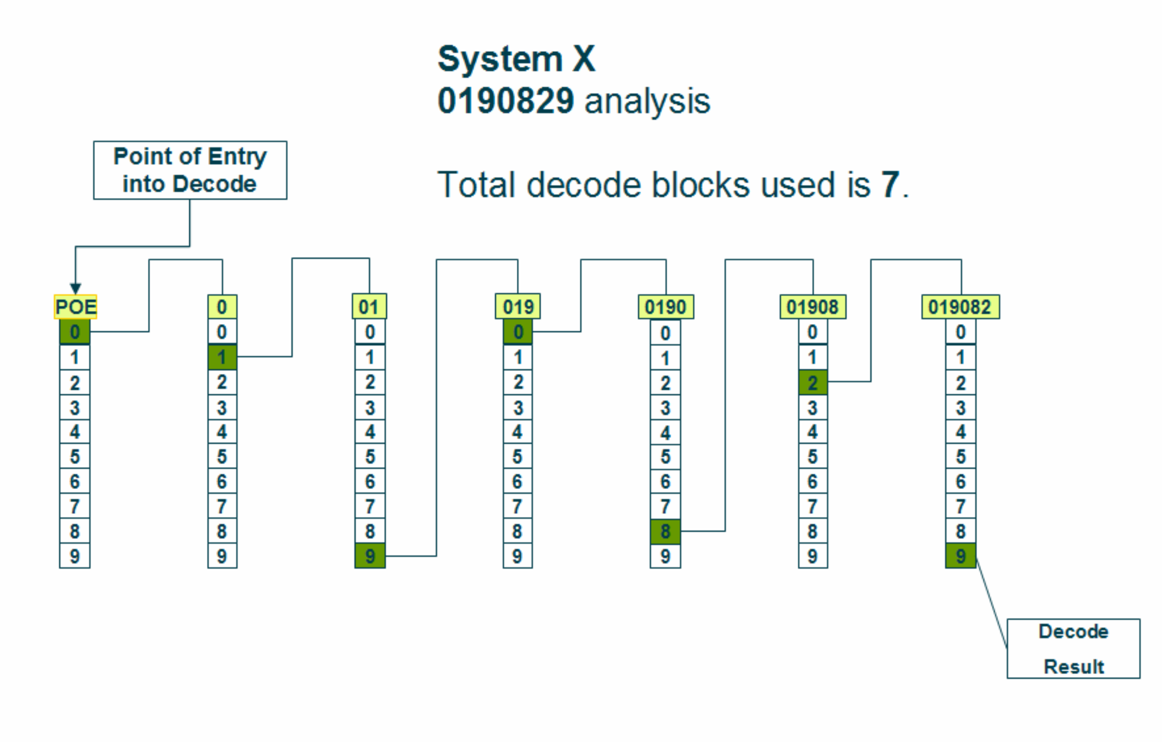
Here is the same decode tree using the variable length block system:



As can be seen, with this system there is no space wasted by unused ‘spare’ levels, so the overall capacity limit is described in terms of analysis lines, rather than blocks.

A3 DIGIT DECODING IN MARCONI'S SYSTEM X

System X uses fixed length decode blocks to create branching trees by which digit decode is performed. The following diagram shows how the number 0190829 would be analysed using 7 decode blocks.



Clearly, if the 10k block 0190829 is to be broken down into 1k blocks, one more decode block is needed. If 50 conservation areas were introduced and all the 1k blocks were initially constrained within a single 10k block in each area, then 50 extra blocks would be needed.

System X has a limit of 34944 decode blocks.

A4 DIGIT DECODING IN ERICSSON'S AXE SYSTEM

The AXE system uses the variable length decode block system. The finite constraint in AXE is 64k lines of decode. But this is broken into two, one area being used for live working, and the other being used for building a new decode table. Thus the real limit is 32k lines. This may seem to be of a similar order of magnitude to System X, but in practice the resource is different and is used in a different way. On the plus side, the decode table is not used to decode the local customer numbers on the exchange. System X could be said to be wasteful as blocks consume space for 'spare' levels within blocks, whereas AXE only has entries for valid codes, but the resource in question are these lines of code and not the block of 10, so AXE is more limited in its overall capability. To decode 0190829 AXE would build a sequence of decode tables with the following lines:

0	Point to next table	
01	Point to next table	
019	Point to next table	
0190	Point to next table	
01908	Point to next table	Charging determined here
019082	Point to next table	
0190829		Routing and number length determined here

Note that with AXE, charging, routing, number length etc can be determined at different levels of the decode.

This decode uses 7 lines, so appears to be similar to System X with its 7 blocks. But whereas System X would only need 1 extra block to open up the 10 1k levels, AXE would need 10 lines of code, assuming all 10 levels were allocated. 50 conservation areas would mean up to 500 extra lines of code. In practice, it would be one line for every 1k block that Ofcom allocated. So the impact of 1k routing would be greater on the AXE system.

A5 NUMBERING IN MOBILE NETWORKS

GSM networks use two different numbering systems. Customers call and text to mobiles using the E.164 numbering system, the same worldwide system used for fixed lines. This comprises:

Country Code + Area Code + number

e.g.

44 + 7953 + 123456

Internally, GSM networks use another numbering system E.212, introduced to overcome some of the non-standard arrangements that had become part of the old E.164 system, e.g. variable number lengths, shared country codes.

An E.212 number, otherwise known as an International Mobile Subscriber Identity comprises:

Mobile Country Code + Mobile Network Code + handset number

e.g.

234 + 15 + 10 digits

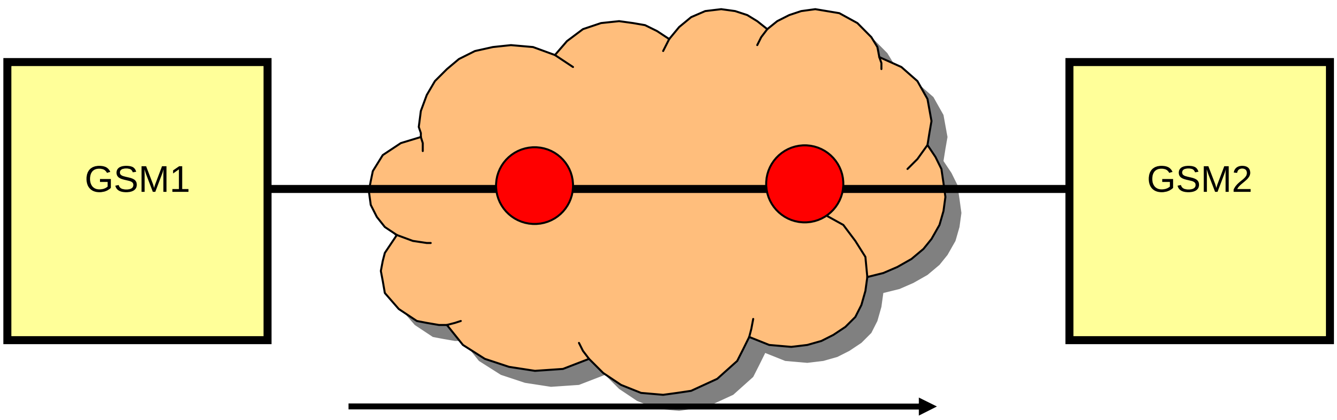
The IMSI is stored in the SIM card of each mobile phone.

When a mobile roams abroad, the foreign GSM network needs to access the Home Location Register (HLR) in the subscriber's home network to find out details about it and to update the HLR with the latest location for the phone. To do this, it sends a message through the international C7 signalling network. However, on a global basis, few GSM networks have direct interconnections and have to send such signals through the international network using the same network provided for ordinary voice calls, although via the signalling channels only. For the most part, C7 networks use the signalling point codes of each exchange to send messages across the signalling network, but that would be complicated for really global working, as any point code changes would need promulgation across the globe. Added to that, there are separate systems for international and national points codes (a bit like public and private IP addresses). So the signalling network is overlaid with functionality called the Signalling Connection Control Part (SCCP) which handles such non-circuit related messages using the familiar E.164 addressing system.

The implication of all this for GSM, is that any message addressed by an IMSI has to have the mobile country code and mobile network code translated into the traditional E.164 country code and area code in order that remote GSM networks can exchange messages (using MAP – the Mobile Application Part) using the worldwide SCCP network. This is called Global Title Translation and the main steps are as follows.

1. a roaming phone sends it IMSI to the host network
2. the first 5 digits are matched to MCC and MNC (e.g. 234 for UK, 15 for Vodafone
3. these digits are removed and replaced by E164 country code and local prefix (44 for UK and 385 for Vodafone
4. the message is marked as having E214 number plan (which is an adjunct to E212) & is routed on global title
5. de-translation is a lookup of the original MCC + MNC for step 2

In practice, not all C7 exchanges have SCCP functionality, so GSM networks have to agree which SCCP gateways are to be used to route messages between them. The figure below shows the principle.



Routing via SCCP gateways in the international network using E.164

For MAP messages, translation into E.164 format is necessary to carry it across the international network, although the embedded MAP message still carries the full IMSI number.

In the case of sending text messages from one country to another, the short message is already addressed in E.164 format, but the originating GSM network needs to decode this number to decide which SCCP gateway should carry the message.