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Numbering Trends: A Global Overview

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Numbering trends – a global overview

Executive summary

Pressures on numbering plans include:

- growth in demand both for fixed lines and for numbers required per line;
- many new non-geographic services, especially mobile but also specially tariffed services like freephone, requiring distinctive numbering;
- market liberalisation, requiring fair access to numbering resources for all competitors;
- newly aware and demanding consumers.

New technology provides new freedom in the design of numbering plans. Cost-benefit considerations show that this freedom should be used to make plans as user-friendly as possible.

Requirements of numbering plans

Users generally value numbers:

- **for making calls correctly**. This means short numbers, infrequent changes, and uniform number patterns.
- **for receiving calls correctly**. Users prefer to keep their own number when moving locally or when changing local operator.
- **for deciding whether to make a call**. This means that the first few digits should give easily recognisable information (eg on likely call cost).

Network operators want the plan to promote:

- **economical network operation**: this means it should conform with network constraints, and should change infrequently;
- **traffic stimulation**: this means it should be customer-friendly, and number supply must be plentiful;
- **fair competition**: the scheme should be managed fairly by the regulator.

Competitive requirements include:

- **local number capacity** for new fixed network operators in each area where they plan to operate.

- **mobile numbering capacity** for mobile operators. This is usually allocated within ranges that the public recognise as meaning “mobile phones” (and higher charges apply).

- **carrier selection codes** for indirect long-distance carriers, to enable their services to be accessed call-by-call.

- numbering **capacity for new services.**

- access to **short codes** on similar terms to the incumbent.

- **operator number portability**.

Developments at world level

Demands for country codes have increased greatly in recent years for new countries, new non-geographic global services, new global networks, and regional groupings. ITU's Study Group 2, who are responsible for this limited resource, are therefore reviewing the use of country code space.

The ITU E series of recommendations (led by E.164) has enabled the world’s telephone networks to connect and route international calls. As a result:

- international significant numbers are limited to 15 digits, with at most the first 7 of these needing to be analysed for routing and charging purposes;

- The trunk dialling prefix 0 is now almost universal, where a trunk prefix is used at all. The main exceptions are a few CIS countries still using 8, and the NANP which uses 1.

- The international dialling prefix 00 is now very widespread

- Countries which use zero as a first significant digit (diallable internationally) risk receiving misdialled calls from other countries.

Developments at regional level

Harmonisation of numbering plans, making them more similar and therefore easier to use, is pursued in two main ways:

- By the adoption of common principles for numbering plan design.

- By identical or similar choices of code for special services and new services.

Both are long-term undertakings. Changes are rarely thought worthwhile simply for reasons of harmonisation. But if changes are needed anyway for reasons of capacity or competition, then groups of countries often prefer to make those changes in a harmonised way.

Emergency codes are especially important. Arguably, a familiar emergency codes should never be withdrawn as it may be the only thing people remember in a crisis.

Regions that have addressed these issues include Europe, South Asia and the broader Asia-Pacific region.

The major successful example of an integrated numbering plan is the North American Numbering Plan. The United States of America, Canada, and several Caribbean countries have a uniform integrated numbering plan behind the single-digit country code +1. This constitutes the only major world region which seems unlikely to move towards conformity with ITU recommendations.

Other examples of numbering integration can be found in Germany, Korea and France. But examples of movement away from numbering integration are much more numerous, including:

- new codes for: the breakups of the former Soviet Union and Yugoslavia; the splits of Czechoslovakia and Pakistan; the independence of East Timor, Namibia and Eritrea; the Palestine Authority, and 4 small countries in Europe;

- abandonment of attempts at integration in North and East Africa;

- Hong Kong's return to China without change to its numbering plan.

In the early 1990s, much effort was devoted to exploring the prospects for an integrated European numbering plan, on the NANP model. This was finally abandoned on grounds of excessive cost. In its place is the +3883 European Telephony Numbering Space.

Advantages of independent country codes and numbering plans include:

- Numbers can be shorter.

- Codes can be chosen to suit local circumstances.

- There is more freedom to choose the routing of inbound international traffic.

- The plan can be expanded as and when required locally.

An alternative way to make international calls look like national calls is to provide special dialling codes for countries which are nearby, or with which there is a special relationship.

Numbering plan design

Designing a numbering plan with the right capacity is an art, not a science. The need to plan long-term leads to huge uncertainties which often swamp any apparent near-term clarity.

In theory, a NSN length of n digits yields 10^n numbers, but not all of these numbers can be used. This is for several reasons, most significantly because of structure which provides useful information but inevitably leads to inefficiency. Typically, utilisation of 40% might be thought reasonable for individual geographic numbering areas. Much lower utilisation is likely for entire geographic numbering plans. Higher utilisation of up to 80% may be achieved in non-geographic number blocks.

It is very hard to predict number demand accurately. The ETO has produced guidelines on numbers per person for planning in Europe. The sensible approach for numbering planning in low teledensity countries must be to build on a realistic vision of the country's state of development and per capita income in 20 or 30 years' time.

The obvious answer to capacity problems is just to add a digit, or even two digits, to the national number length. However, every extra digit dialled increases errors, so countries need to think carefully before adding digits, especially when their populations are large and their income levels low.

Developments at national level

A common feature of numbering plan reviews has been simplifying geographic structures, often combining two or more small geographic code areas into one large one. This is quite a costly exercise but has several advantages.

Regular review of geographic NDC utilisation is essential to ensure that relief plans are always in place for areas which may exhaust. For each area at risk of number exhaustion within the next decade, decisions are needed on number conservation measures (if any), and on a capacity expansion path, with appropriate number ranges reserved for the purpose.

Several world cities have by now moved to 8-digit local numbers. They include London, Paris, Tokyo, Beijing, Rio de Janeiro and Mexico City. Others which have stayed with 7-digit local numbers (including all large cities of North America) have been obliged to introduce additional codes.

The main advantages of an open scheme (one with separate local and trunk dialling procedures) are that customers can dial shorter numbers for local calls, and that geographic area identities are maintained (together with the associated tariff indications). The main advantages of a closed scheme, on the other hand, are a uniform dialling procedure for all calls, and a higher

possible capacity utilisation. Also, the trunk prefix is usually no longer needed, and if it is dropped, one dialled digit is saved on national calls.

In many larger countries with longer numbers, open schemes remain and may well do so indefinitely. But the balance of advantage is moving towards closure, as increasingly:

- a high proportion of calls is in any case dialled with a full national number (often in part because of a rise in calls to and from mobile phones);

- many people use dialling aids (eg memory phones) and so are little affected by the number of digits required for a call;

- there is little difference in cost between a local and a long-distance call, so no effort need be spent on finding out the exact tariffs.

The closure option is one that most countries will want to keep open in case it looks desirable at some future time.

Nearly all countries with access network competition (including the NANP) have decided that for both competitive and human factors reasons, all competitors must share the same set of geographic codes. Otherwise, users may get confused by rival geographic code structures, new competitors are at a disadvantage because calling them looks as if it is long-distance rather than local, and operator number portability is hampered.

Operator number portability in the fixed network has become a standard requirement in high teledensity countries with fixed line competition. Portability makes it much easier for customers to switch operator, and is widely seen as a desirable way to "oil the wheels" of competition. Operator portability is also of interest between mobile networks and between providers of special services such as freephone.

Carrier selection means enabling customers to choose who carries their long distance or international calls, regardless of which local network they are connected to. Decisions needed include:

- the choice of codes (and their placement in the dialled digit sequence) for **call-by-call carrier selection**. Prefix, insertion and substitution approaches are all in use. The prefix approach offers most flexibility and is preferable long-term.

- introduction of **carrier preselection** (ie ability for a user to nominate his own default carrier when no call-by-call selection is made);

- **default procedure for carrier selection** when the customer has not made a conscious choice of carrier.

There is little pattern in codes chosen for specific new services. The most popular choices of code for non-geographic services seem to be:

- first significant digit 1 or a late digit (especially 9, 7, or 6 for mobile, 8 for specially tariffed services);

- second significant digit 0 - the X0 and especially the X00 series. The best examples are 800 and 900.

Using the 1xx range for short codes is common, though not universal. This range has been the focus of many harmonisation efforts. To date the only widespread success is implementation of the general emergency code 112 across Europe and by many GSM networks worldwide. Use of 1xx and especially the 10x subrange for carrier selection codes is also common.

Regulatory aspects

There is very widespread agreement that:

- the national telephony numbering plan is a national resource;

- it should be managed in the overall national interest;

- in a competitive environment, the regulator needs to make sure that this happens.

Regulators do not need to take on the day-to-day running of a numbering scheme, but they must:

- maintain a long-term vision for the numbering scheme, taking responsibility for the choice of scheme architecture.

- regularly consult all interested parties, with particular concern for users.

- decide on and make public the basic rules governing the use of the numbering scheme.

- allocate number blocks to network operators, observing the principles of good husbandry.

- set rules for related competitive issues, in particular, carrier selection, operator portability, and number information databases and services.

- resolve any disputes.

New telecoms legislation or regulations should establish a system of rights and obligations covering:

- overall national **ownership** of numbers, enabling the regulator to control use of the numbering plan in the national interest.

- **allocation** (rental) of number blocks to network operators and maybe service providers, subject to reasonable conditions.

- **rights of use** by service providers and end customers.

- a clear understanding of **intellectual property** in numbers.

- a framework to permit **trading** in individual numbers.

Good economic arguments can be advanced for **charging for numbers** at least on a cost-recovery basis, and many countries are now doing so.

The plan itself, any rules relating to it (often referred to as “numbering conventions”) and allocations from it should be clearly documented and a matter of public record. Exactly what rules are needed will vary – while some countries have long and complex documentation, others find a short and simple collection of rules enough.

Regulators in many countries have found Numbering Advisory Committees useful. These comprise industry experts and sometimes also user representatives and/or independent experts such as academics.

When considering options for the future of a numbering plan, important factors include:

- providing adequate numbering capacity (in both quantity and quality) for all foreseeable needs for the chosen planning period;

- being evolutionary, not revolutionary - ie being realisable through a step-by-step migration path from the status quo;

- long term flexibility;

- the ability to provide parallel running and changed number announcements (normally achieved by avoiding overlap of number ranges between old and new numbering plans).

In high-teledensity countries there is usually a desire to delay change for as long as possible. Low teledensity countries, on the other hand, especially if they are small, may do better to change their numbering plan sooner rather than later.

A checklist of numbering change implementation requirements includes:

- changes to exchanges of different types, including recorded announcements for misdialled calls.

- changes to operational support systems (eg directories, any computer system holding telephone numbers).

- carefully thought out publicity programmes for international correspondents and the general public.

- a period of parallel running of old and new plans, to enable large business systems to be reprogrammed gradually.

- support for changes to customer premises equipment, especially payphones and automatic alarms.

Introduction

This review of trends in numbering plans around the world has been commissioned by the USAID-funded RAPID telecoms project on behalf of TRASA, the Telecoms Regulators' Association of Southern Africa, as part of a study of numbering harmonisation among their countries. TRASA covers 14 countries with very varied characteristics – for example teledensities (fixed plus mobile) vary between 0.3 (DR Congo) and 82 (Seychelles). However it is predominantly a low-income and low-teledensity region. Competition is just beginning in the region. The review therefore covers numbering developments broadly, from a regulator's viewpoint, with a special focus on harmonisation, the needs of low teledensity countries and the start of competition. The review relates to E.164 (telephony) numbering plans, which present by far the greatest management challenges.

The review draws on many people's work. Thanks are due to Riley Allen of Chemonics International and Internews, Roy Blane of Inmarsat and ITU Study Group 2, Ron Conners of NANPA, Richard Hill of ITU, Vince Humphries of ETO, David Lewin of Ovum, and Ralph Adam, who provided comments on a draft. Naturally, responsibility for errors and omissions remains with the author. Thanks also to representatives of regulators and telephone companies with whom I have discussed numbering, in Australia, Bangladesh, Botswana, Chile, Colombia, Cyprus, Denmark, East Timor, Finland, the Gambia, Germany, Hong Kong, India, Jordan, the Maldives, Malta, Nepal, the Netherlands, Pakistan, Portugal, Spain, Sri Lanka, Sweden, Switzerland and the UK; and especially to the ITU, who funded most of the assignments in developing countries.

Pressures on numbering plans

Different countries are at different stages, but the whole world is experiencing similar telecommunications trends. Most national numbering plans were originally devised thirty or more years ago. We cannot expect them to remain adequate in today's conditions, which could not then have been foreseen, of:

- sustained **growth in demand for fixed lines**, and emerging **growth in numbers required per line** (because of direct dialling in (DDI), differentiated ringing, ISDN and so on);

- a proliferation of **new non-geographic services**, especially mobile which is overtaking fixed service in many countries, and specially tariffed services like freephone, requiring distinctive numbering;

- **market liberalisation**, with new competitors entitled to numbering resources on the same terms as traditional operators, and independent regulators increasingly taking on responsibility for overseeing fair allocation;

- newly aware and **demanding consumers**, who may call for numbering that is easy to use and that clearly indicates call cost, while at the same time resisting any change.

Some key considerations

Coincident with these new pressures on numbering schemes, there is now new freedom in their design. The design of the first generation of national numbering schemes was largely dictated by the step-by-step switching systems that numbers had to operate half a century ago. Redesigned numbering schemes can take advantage of a new level of technological flexibility, and be designed to meet other criteria.

Numbering plans were traditionally managed by incumbent telecoms operators in what they perceived as the national interest, which naturally tended to match their own interest. It is easy for a regulator faced with a numbering problem to be guided by the industry, and in particular by a strong incumbent. But qualitative cost-benefit analysis of numbering scheme options shows that user interests (including those relating to enhanced competition) usually dominate a “national interest” equation.

True, the incumbent's costs in any change will be larger than any one other party's. But because users are many, even if individual costs are small they will probably outweigh the industry's in aggregate. Similar arguments hold good for benefits (though these are even harder to pin down accurately).

Of course numbers have to enable calls to be correctly routed and charged, and network aspects are vital when plans are reviewed. But competition and human factors aspects are now also vital, and numbering planning cannot be left to engineers.

The rise of the internet has led some to ask whether E.164 numbering will be obsolete within the life of current numbering plans. The answer cannot be certain, but in all probability is no. The plain old telephone with its simple user interface has become too deeply entrenched to disappear that fast, even if cheap internet terminals become widely diffused. Rather, at any rate for a long transitional period, the internet is likely to lead to a rise in demand for telephony numbers, for example to access internet services.

It is important to recognise that the numbering plan is only an enabler for telecoms growth and development. A well-designed scheme will permit changes in the industry, the market and tariffing practice, but it cannot bring about such change. A badly designed scheme could severely constrain change.

Structure of the paper

The next sections explain some basic terminology, and look in more detail at the requirements placed on numbering plans by users and by the industry. Later sections of this paper:

- show how numbering plans are changing at national, regional and global levels, and

- provide some guidance to regulators and others who are responsible for developing these plans.

Illustrative material from different numbering plans is provided throughout, mainly in boxes or figures. The information has been derived from a variety of sources, mainly but not only regulators' websites. Overall, the picture is sufficiently accurate for the illustrative purposes for which it is used here. However, please check any individual item before using it for other purposes.

Terminology

- Dialling an international number normally starts with the *international prefix* (usually, but not always, 00) followed by the country code. All the rest of the digits constitute what is known as the *National Significant Number* (NSN). This is the same as the full number that you would dial to reach the same person from within his home country, but without the *trunk prefix* if there is one (usually 0). The NSN in turn may be split into two parts: first the *National Destination Code* (NDC), often called the *trunk code* or *area code*, and lastly the *Subscriber Number* (SN).

The terms *(national) numbering scheme* and *(national) numbering plan* are here used more or less interchangeably to mean the uses assigned to NDCs and the rules for SNs within NDCs. Sometimes *scheme* may mean the larger national design while *plan* denotes a particular operator's part in that scheme.

The *numbering plan* refers to NSNs, while the *dialling plan* refers to the digits dialled by a caller. A full national number from the numbering plan identifies a particular call destination (eg a subscriber) uniquely, and the effect of dialling it should be the same from all access networks. Short codes are part of the dialling plan because the effect of dialling them may differ depending on the access network to which the caller is connected.

Numbering and dialling plans are different where *local dialling* is permitted - this means that just the SN is dialled for connection to another user in the same NDC area. A single SN, say 234567, may be assigned to a different customer in each different NDC area. This kind of plan is known as an *open numbering plan.* The alternative, a *closed numbering plan,* exists where there is only a single dialling procedure for all national calls.

Requirements of numbering plans

User requirements

Perhaps surprisingly, given the great economic importance of user factors in the design of numbering schemes, few systematic research results on the subject are available. However, those that exist are generally consistent[1]. Users value numbers:

- **for making calls correctly**. This means that numbers should be easy to remember or find, and to reproduce accurately. In turn, this means short numbers and infrequent changes. There is also a widespread preference for a single NSN length and for uniform number patterns (such as the North American Numbering Plan (NANP) xxx xxx xxxx layout), even at the cost of dialling extra digits – familiar patterns increase user confidence and reduce dialling errors

- **for receiving calls correctly**. This means that numbers should not be readily misdialled from other much-called numbers, and should change infrequently. Users would prefer to keep their own number when moving locally, or when changing local operator without moving premises.

- **for deciding whether to make a call**, or whether to bar certain types of call in their own equipment. This means that the first few digits should give easily recognisable wanted information (eg on likely call cost, or on location of the called party). Users are rarely interested in the identity of the network operator, and do not want this information displayed in the number. Most people can only remember the meaning of under a dozen codes, and the shorter these are, the better they remember.

Users also have some differences of opinion among themselves, for example:

- they are not always united on the issue of closed versus open numbering plans (discussed in 0 below). Keeping local dialling matters more to residential users and in countries where there are long trunk codes. Business users, who tend to make more long distance calls and to have more modern phones, may favour a single dialling scheme for all calls[2].

- the significance of special numbers varies depending on cultural factors. An obvious example of this is Hong Kong, and elsewhere in East Asia, where certain combinations of digits are seen as lucky or unlucky.

- users' views on the desirability of international harmonisation (eg of short codes) vary depending on how much the people questioned themselves travel or have an international outlook.

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[1] The findings quoted are based on fieldwork, mainly from the early 1990s and no longer easily accessible, in the UK by Ovum Ltd, the regulator Oftel, and the TUA and TMA user organisations; by the regulator Austel and the telco Telstra in Australia; and by Ovum in Hong Kong and the European Union.

[2] NANP area code relief options often run into such conflicts – Southern California is a current example.

Users' preferences in relation to number portability are also unclear, and can change fast. Operator portability fosters competition, which is usually believed to be in customers' long-term interests. However, number portability has a cost. Certain jurisdictions apply the costs of number portability evenly across all consumers, including those who do not plan to change operators, on the grounds that the policy benefits everyone through enhanced competition in the sector.

Even those who do plan to change operators may not choose number portability if the full cost is reflected in a direct customer charge. Some prefer an alternative such as a changed number announcement.

Looking at geographic and service portability, a balance must be struck between portability and meaning in numbers. In the extreme, number portability across service and geographic boundaries comes at the cost of a loss of meaning. The customer who is moving location or service may prefer to keep his number, while someone needing to call this customer may be confused if he does keep it.

Industry requirements

Of course, the industry also has a vital interest in numbering plans. Network operators want the plan to promote:

- **economical network operation**: this means it should conform with network constraints, and should change infrequently;

- **traffic stimulation**: this means it should be customer-friendly, and number supply must be plentiful; "attractive" numbers should be available to service providers and end-users on a fair basis;

- **fair competition**: the scheme should be designed and managed fairly by a neutral party, such as the regulator.

Encouraging users to make calls has already been discussed above. Here we look further at network requirements. Competitive requirements are dealt with in the next section.

With old step-by-step exchanges, each digit corresponded to a switching stage. There was therefore a strong cost incentive to keep numbers as short as possible. With common control exchanges, the cost link is much less significant, but is still influential in numbering plan design. The focus now is usually on minimising the number of digits that need to be analysed in order to determine the routing and tariffing of each call. Analysing more digits requires more call processing capacity and increases post-dialling delay.

Misdialled traffic also ties up valuable equipment unproductively, so there is good reason to design numbering plans and to allocate numbers in ways that minimise misdialling.

When a major numbering change is in prospect, naturally attention focuses on the network costs of change, and these can indeed be large. However, they should occur only once in a long period. It is important to keep them in perspective. Even a tiny percentage traffic stimulation effect brought about by an improved numbering scheme can rapidly pay for the costs of numbering change.

Competitive requirements

The requirements that new competitors have of national numbering plans are fairly standard. How these requirements are met is discussed more fully in section 0 below.

In National Destination Code (NDC) space, new competitors have the following requirements:

- New fixed network competitors require adequate **local number capacity** in each area where they plan to operate. The usual approach is for all competitors to share any geographic significance of numbers.

- New mobile operators similarly require **mobile numbering capacity**, which is usually allocated without geographic significance but within a range or ranges that the public recognise as meaning "mobile phones" (and, often, "higher charges apply").

- New network operators and service providers require numbering **capacity for new services.** Again, it is usual, in accordance with user preferences, for all competitors to share nationally recognised codes for services such as freephone, or premium rate.

Demands are also made on short code space:

- Long-distance competitors require (preferably, short) **carrier selection codes** to enable their services to be accessed call-by-call. Short carrier selection codes are much less important if equal access preselection is introduced for long-distance carriers. Individual selection then takes place less often and longer codes are acceptable.

- New local loop competitors will want similar access to **short codes** as is enjoyed by the incumbent. Since these codes can be re-used by each access network, this is a relatively easy one to solve in capacity terms.

- The ITU[3] draws a useful distinction that carrier selection reflects a choice made by the caller, while network identification (usually one of the

[3] In Supplement 1 to Recommendation E.164 on *Alternatives for carrier selection and network identification.*

three NDC space requirements above) reflects a choice made by the called party.

- Last but possibly most problematic is **operator number portability**, which we have already touched on from the user viewpoint. Portable numbering is most important for new competitors who are targeting small business customers, for whom a change of number would often be disastrous. Number portability is less important for large businesses, which may be able to keep separate lines (using their old number) for incoming traffic, while routing outgoing calls through a new operator. Also, some residential customers may be able to cope with a number change.

Global developments

Country codes

- International direct dialling relies on each country having a unique *country code* which identifies it from everywhere in the world. Country codes have 1, 2 or 3 digits. Only two 1-digit country codes have ever been issued - 1 for the North American Numbering Plan and 7 for the former Soviet Union. There are only 43 2-digit country codes, belonging in general to the more industrialised or more populous countries, including 16 in Europe. The remaining allocated country codes all have 3 digits. There are only about 80 spare 3-digit codes, and 30 of those (the complete 2-digit codes 28, 83 and 89) have been reserved against the eventuality of needing to expand country code lengths.

Demands for country codes have increased greatly in recent years for:

- new countries (such as the republics of the former Soviet Union) which no longer want to share country codes;

- new non-geographic global services such as universal international freephone services (for which +800 has been allocated), universal international shared cost services (+808), universal personal telecoms (+878), and international premium rate services (+979)[4];

- new global networks, for which the code +882 is now in use, and global satellite networks, for which the code +881 is in use[5];

- the regional grouping of the European Union, which has been allocated the code +3883[6] to use throughout Europe for special European services.

- ITU's Study Group 2, who are responsible for this limited resource, are therefore reviewing the existing and future use of country code space. The first digit of a country code was originally regional - 2 for Africa, 3 for Europe and so on – but as this increased the difficulty of finding new codes, regional significance has already been dropped (as is evident, for example, from the code 299 for Greenland).

Figure 1 summarises the use of geographic country codes by world region. It shows considerable discrepancies in numbering space available both per person and per line, most notably between China and India on the one hand and Russia and Kazakhstan on the other.

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[4] For more information on these developments see http://www.itu.int/ITU-T/universalnumbers/index.html and http://www.teledanmark.dk/itff/

[5] The next two digits identify the specific network. For details see http://www.itu.int/ITU-T/inr/forms/files/Applications-E-164.doc

[6] Or, strictly speaking, the first digit identification digit 3 within the shared country code +388 assigned by the ITU for “groups of countries”.

	Africa	North America	South America	Europe	CIS[7]	Oceania	India	China	Rest of Asia	total
Population (m)	800	330	510	590	160	30	1030	1300	1350	6100
Countries[8]	53	17	25	42	2	13	1	1	42	196
Lines (m) (fixed + mobile)	44	352	164	593	43	26	40	324	398	1984
First digits of c codes[9]	2	1	5	3, 4	7	6	91	86	6, 8, 9	
1-digit c codes used	0	1	0	0	1	0	0	0	0	2
2-digit c codes used	2	0	8	16	0	2	1	1	13	43
3-digit c codes used	59	0	20	29	0	18	0	0	31	157
3-digit c codes spare	22	0	0	10	0	0	0	0	50	82
m pop/ 3-digit code	10	3	5	3	2	1	103	130	8	8
m lines/ 3-digit code	1	4	2	3	0	1	4	32	2	3

Figure 1 Country code resources by region

Much current international activity focuses on procedures for mapping telephone numbers to internet domain names (ENUM[10]). This is a large subject in itself and beyond the scope of the current paper. Its main relevance here is that by making it easier for people to access internet services using a telephone, it may increase demand for these services and for corresponding numbers.

This may require new codes for new services and thus the use of spare space behind existing national codes. This may be turned to commercial advantage. A current example is the Global 269 freephone service operating behind the Comoros country code +269[11]. In October 2001 an ITU circular[12] argued strongly against such arrangements. Among other reasons, they may be in violation of ITU-T Recommendation E.190[13].

[7] Residual users of former Soviet Union country code +7 (Russia and Kazakhstan).
[8] "Countries" are as listed in ITU basic indicators (from which the population and lines figures are taken, with some rounding, both for 2001). Country codes have been allocated to a number of additional territories (mainly very small), which offsets the shared NANP country code and accounts for the larger totals for allocated country codes than for countries.
[9] "c codes" means country codes.
[10] See for example http://www.itu.int/ITU-T/inr/enum/index.html
[11] See http://www.global269.com
[12] http://www.itu.int/itudoc/itu-t/circ/01-04_1/066.html
[13] Clause 6.2.6 of Recommendation E.190 states that: "E-Series numbering resources will only be utilized by the assignee for the specific application for which they have been assigned by the TSB." and "Numbering resources may not be sold, licensed or traded. Nor may they be

International recommendations and harmonisation

The ITU E series of recommendations (in particular E.164 and E.190[14]) have enabled the world's telephone networks to connect and route international calls. Major provisions of E.164 are summarised in Box 1.

International Recommendations are just that – they cannot be binding on countries. However, the two provisions in

Box 1 relating to international digit analysis (numbers 1 and 6) determine the capabilities of international exchanges. Countries which use more than 15 digits in their international significant numbers, or which need more than 7 digits to be analysed for routing and charging purposes, have to accept that they may lose inbound traffic from some parts of the world. For this reason these two provisions have been very widely, if not universally, implemented.

The other provisions are only made to increase ease of use and as such have less force. However nearly all countries are harmonising their trunk and international prefixes when they make other changes in the numbering plan[15].

- The trunk dialling prefix 0 is now almost universal, where a trunk prefix is used at all. The main exceptions are a few former Soviet countries still using 8, and the NANP which uses 1. In addition some countries, mainly in South America, have implemented trunk carrier selection by putting an extra digit or digits between the trunk prefix 0 and the rest of the number. This may be seen as a set of alternative trunk prefixes.

- The international dialling prefix 00 is now very widespread. Exceptions include Japan (010), the NANP (011), Australia (0011), a few former Soviet countries (810), East Africa (000)[16]. Again, some countries have implemented international carrier selection by inserting extra digits between the prefix and the rest of the number, which may be seen as a set of alternative international prefixes.

transferred, except in the case of a merger, acquisition, or joint venture."

[14] Principles and responsibilities for the management, assignment and reclamation of E-series international numbering resources

[15] Summaries of dialling procedures in all countries are published from time to time at http://www.itu.int/ITU-T/bulletin/annex.html

[16] Kenya, Uganda and Tanzania use 00x (x=4, 5, 6) for short regional dialling among them.

1. Numbers should be no longer than necessary. From 1 January 1997 (time-T), the maximum number of significant digits to be dialled internationally is 15 (including the country code but excluding the international prefix and any carrier selection prefix).

2. If a trunk prefix is used, this should be 0.

3. The trunk prefix (usually 0) should not also be used as the first digit of national significant numbers.

4. The number to be dialled to reach a given point, from within the same country but outside its local dialling area (if any), should be the same throughout a country (ie special local or regional dialling codes are to be avoided).

5. Major numbering plan changes should be publicised internationally 2 years in advance.

6. It must not be necessary for a remote exchange to analyse more than the first 7 significant dialled digits to determine how to route and charge for a call. Where the country code has 3 digits, this leaves at most 4 digits for this purpose in the national numbering plan.

7. The international prefix should be 00 (though national arrangements may be made for distinguishing among different international network operators and/or services).

Box 1 Major provisions of ITU recommendation E.164

Provision 3 is there because of the general advice given to callers that when dialling internationally, they should drop any trunk prefix shown at the front of a number – and this usually means dropping a zero. Countries which nonetheless use zero as a first significant digit (diallable internationally) therefore risk receiving misdialled calls from other countries. Unfortunately, some countries are now using a leading zero as a first significant digit, in order to expand the numbering space quickly and inexpensively. For example, Italy and Switzerland appear to have recently adopted this method, but it may be only an interim measure.

Regional developments

The last decade has seen several attempts at developing numbering at regional levels. These efforts are of two main kinds:

- Regional harmonisation of national numbering plans.

- Integrated numbering plans (where countries in a region share a country code or dialling procedure).

Regional harmonisation

Obviously, every national numbering plan must be unique, in particular its geographic component. Harmonisation of numbering plans, making them more similar and therefore easier to use, is however pursued in two main ways:

- By the adoption of common principles for numbering plan design. Emerging common principles are discussed in the next section[17].

- By identical or similar choices of code for special services and new services.

Both are long-term undertakings. Changes are rarely thought worthwhile simply for reasons of harmonisation. But if changes are needed anyway for reasons of capacity or competition, then groups of countries often prefer to make those changes in a harmonised way.

Any country considering harmonisation will need to think carefully about:

- With whom do they wish to harmonise - near neighbours, trading partners, political allies, countries sharing a common language or culture, sources of tourists?

- Who will benefit from the harmonisation – foreign visitors, people who travel or call abroad, the public generally?

- Do the benefits of harmonisation justify the costs?

The answer to the last question is much more likely to be "yes" when codes are being assigned for the first time in a harmonised way (*prospective harmonisation*) than if they call for change of existing codes which may be familiar and well-used (*retrospective harmonisation).*

Emergency codes are especially important. Arguably, a familiar emergency codes should never be withdrawn as it may be the only thing people

[17] See, in particular, chapters 6 and 7 of the ETO report on review of national numbering schemes on their openness to competition, 1997, "*Basic guidelines for developing national numbering schemes"* and *"Guidelines for fundamental changes*".

remember in a crisis. Of course new, harmonised codes can be introduced as well. In the UK, for example, there is no intention of withdrawing the well-known 999 emergency code although the European standard code 112 is available in parallel[18].

The CEPT/ECTRA (Conference of European Posts and Telecoms/European Committee for Telecoms Regulatory Affairs) Recommendation of 10 December 1998 on Guidelines for fundamental changes to National Numbering and Dialling Plans recommends:

- That the number of geographical numbering areas is reduced to achieve more efficiency in the usage of the total available numbering capacity.
- That national dialling sequences beginning with the digit 1 are recommended for access to special services/facilities (e.g. emergency services, directory enquiry) in order to facilitate easy recognition of these sequences and their possible harmonisation.
- That at least one value of the most significant digit of the N(S)N is left spare to allow flexibility for future changes.
- That if the N(S)Ns beginning with 0 become spare because of a fundamental change, they shall be left spare in order to allow a future harmonised use throughout Europe.

Earlier (4 December 1997) CEPT/ECTRA recommended that the code 118 should be used (in a fair and non-discriminatory manner) for access to voice directory enquiry services.

In 1991 the European Council decided that the emergency code 112 should be implemented throughout the EU, and this has since been recommended for all 43 members of CEPT/ECTRA (now Electronic Communications Committee) and implemented in most of them.

Box 2 European numbering harmonisation recommendations

Regions that have addressed these issues include Europe, through the ETO[19], South Asia, through the South Asian Telecoms Regulators' Council (SATRC)[20] and the broader Asia-Pacific region through the Asia-Pacific Telecommunity[21]. The European initiative has been in place for longer and is beginning to show results as more countries (especially those further east

[18] It is said that more UK schoolchildren think the emergency code is 911 than either 999 or 112 (from watching US television programmes).
[19] http://www.eto.dk/numbering/default.htm and http://www.eto.dk/ceptectra/rec.htm
[20] http://www.aptsec.org/satrc/Third-SATRC/15_RECOMMENDATIONS.doc
[21] http://www.aptsec.org/studygroup/APT-Studygroups.htm (see SQ2.3). A paper by Rakish Agawam (Harmonization of numbering plans to accommodate services such as Intelligent Network, Mobile and Multimedia services etc.) recommends 1800 for freephone and 0900 for premium rate.

with later-developing competition) review their numbering plans. Boxes 2 to 4 show various regional recommendations and proposals, focusing on specific code choices. Recommendations of international harmonisation groups tend to be conservative, as they often require unanimous agreement. However proposals (typically, put forward by study groups but not yet approved by governing bodies) can also be influential. The next section, on national numbering plans, shows how some of these proposals are being adopted.

For harmonised European short codes, the following ranges are identified:

- range '11' in particular for information/assistance services
- a separate range, preferably either range '10' or range '19' but not excluding range '99', if required, for carrier networks
- one or several of the combinations '8xy' with $x \neq 0$, if required, for shared cost services.

(Report on harmonisation of short codes, 1998)

- N(S)Ns starting with digits 6 and 7 should preferably be used for the numbering of mobile and personal communications services.
- N(S)Ns starting with X0 (X=1-9) should preferably be reserved for the numbering of commonly recognised future services.
- N(S)N range 800 should preferably be reserved for freephone services. Range 80X should be reserved for future use (e.g. for expansion and for service differentiation).
- N(S)N range 900 should preferably be reserved for shared revenue services. 90X should be reserved for future use (e.g. for expansion and for service and tariff differentiation).
- In open schemes, NDC range 1 should preferably be left free for future expansion of the scheme, for example to allow for an easy migration from an open scheme to a closed scheme.

(ETO Report on review of national numbering schemes on their openness to competition, 1997)

Box 3 European numbering harmonisation proposals

1. N code “7” be allocated as the UPT indicator (within the NDC) in all countries where it is practicable. 7X will decide the mobile service. The following allocations may be made:

- 70 - UPT indicator
- 75 - Cellular mobile services
- 76 - Paging services
- 77 - Reserved for satellite mobile services

2. N code ‘8’ should be reserved for all the new types of private services that are seen to be coming up. NDC “800” should be allocated to National Freephone and Collect Call Services in the South Asia Region.
3. Code 900 should be allocated to the Premium services.
4. Uniform codes should be adopted for the following services in the South Asia Region:

110 – Directory Enquiry

111 – Spare

112 – General Emergency

113-114 - Specific Emergency

115 – Medical Emergency Services

116 – Spare

117,118 – Operators

119 – Airline Enquiries

(from paper “SAARC – Numbering Considerations” by P K Choudhury, presented to the SATRC meeting in Bhutan, March 2001)

Box 4 South Asian numbering harmonisation proposals

Integrated numbering plans

A different kind of regional numbering initiative is the integrated numbering plan (covering more than one country behind a single county code), or the creation of common regional dialling patterns or numbering space. The major successful example of an integrated numbering plan is the North American Numbering Plan. The United States of America, Canada, and 21 small Caribbean countries have a uniform integrated numbering plan behind the single-digit country code +1. This constitutes the only major world region which seems unlikely to move towards conformity with ITU recommendations. Figure 2 compares some key features of the NANP with predominant features of ITU-conformant numbering plans[22].

[22] The latter set of features are not all required by ITU recommendations.

Feature	ITU-conformant	NANP
Trunk prefix	0	1
International prefix	00	011
Short codes	1XX (100 of these)	N11 (9 of these)[23]
Emergency code	112 (EU, GSM)	911
Live operator	1YZ	0
Carrier selection codes	1AB(C)	10X XXXX
Use of 0	Trunk prefix	Operator
Use of 10	Short codes	Carrier selection on 101xxxx
Use of 11	Harmonised short codes (EU)	Substitute for * on rotary dials
Use of 1X	Short codes	Long distance dialling
Uniformity	Variable but increasing	Complete (1 XXX XXX XXXX)
Geographic relief methods	Extra digit, code changes	Area splits, overlays
Mobile services numbering	Special ranges	Mainly in geographic codes
Special services numbering	Special ranges	X00, 8XX codes (toll-free) NYY also now reserved for new services
Closure	Increasing	Overlay means local dialling lost

Figure 2 ITU-conformant numbering and the NANP

Membership of the NANP has remained rather stable over a long period. No country has left and Guam and Northern Marianas have recently joined. Originally all the Caribbean members shared the single NPA (numbering plan area) code 809. In recent years these small nations have been assigned an NPA code each, thus retaining 7-digit national dialling. The exception is the Dominican Republic, which retained 809. Puerto Rico, however, needs two NPA codes to get enough capacity. Regulators in Puerto Rico opted to use the second NPA code as an overlay, which means that 10-digit national dialling is required[24].

Other examples of numbering integration are:

- the incorporation of East German numbering into the former West German plan (where the first digit 3 had been set aside for this purpose),

- the numbering of several French overseas territories to be uniform with France itself. Calls between France and these territories look like

[23] Because of their scarcity, the uses made of the N11 codes are of particular interest. In general they are reserved for services of special social significance – see for example http://www.211.org/ for a description of health and human services information referrals.
[24] David Leibold's website http://www.wtng.info/wtng-reg.html#CaribbeanNations gives much more detail on numbering in the Caribbean and all over the world.

domestic calls within France, though the territories also have their own country codes which have to be used for calls from the rest of the world[25].

- The 7 range in South Korea remains reserved for the hoped-for integration of North Korea.

Examples of movement away from numbering integration are much more numerous. They include:

- Most notably, the breakup of the former integrated Soviet numbering plan behind the country code +7. All the newly independent states except Kazakhstan and Russia have taken up separate new country codes. As these states review their numbering plans, they are tending to move away from the old Soviet approach to numbering (eg the trunk prefix 8) and towards global or European standards.

- Similarly, the breakup of the former Yugoslavia, the separation of the Czech and Slovak Republics, and of Bangladesh from Pakistan; the independence of East Timor, the separation of Namibia from South Africa and of Eritrea from Ethiopia have all been marked by new country codes. The Palestine Authority has an allocated country code in anticipation of having a country.

- Small countries such as Andorra, Liechtenstein and even the Vatican City have taken up country codes even without a change in their political status. Gibraltar has its own country code but there is some friction with Spain at present about correct routing to this code.

- In North Africa, in the early 1990s, the union of Morocco, Tunisia, Libya and Algeria behind the country code 21 was short lived. They agreed to take separate 3-digit codes instead. Close East African numbering co-operation (among Kenya, Uganda and Tanzania) has been set aside, though special arrangements for dialling within the group have been maintained.

- Hong Kong and Macau have returned to China with no sign of their country codes being changed. The first digit 6 in the Chinese numbering plan was long held vacant for the reintegration of Taiwan, but the capacity is now beginning to be used for other purposes. However, the first digit 0 in Hong Kong's numbering plan remains reserved for possible future "regional dialling" – that is, to permit calls to China to look like national rather than international calls (see more on this below)[26].

In the early 1990s, much effort was devoted to exploring the prospects for an integrated European numbering plan, on the NANP model. This was finally abandoned on grounds of excessive cost. In its place is the +3883 ETNS (European Telephony Numbering Space), which is intended for much more

[25] http://www.art-telecom.fr/dossiers/numero/dom_gb.htm provides full details.
[26] See also the European recommendation in Box 2 to reserve 0 for future harmonised use.

limited uses, such as single marketing or customer service numbers that can be advertised all over Europe[27].

Plainly, country codes and regional codes are potent political symbols. But, politics apart, an independent country code and numbering plan can have significant advantages, especially for the smaller countries involved:

- Numbers can be shorter.
- Codes can be chosen to suit local circumstances.
- There is more freedom to choose the routing of inbound international traffic.
- The plan can be expanded as and when required locally.

The non-political advantages of the integrated numbering plan are:

- Ability to call all countries within the integrated plan without making an international call[28].
- Automatic harmonisation among all member countries of short codes and non-geographic codes.

Integrated numbering plans are very costly to set up (if separate country plans are already in place) and hard work to maintain (with international consensus potentially required for every decision). It is not hard to see why so many countries and regions have decided on separate country codes.

Regional dialling codes

An alternative way to make international calls look like national calls is to provide special dialling codes for countries which are nearby, or with which there is a special relationship. A good example of this is the code 048 provided for calls from the Republic of Ireland to Northern Ireland (instead of 0044 28), though no special code is provided in the reverse direction. The code 07 for calls from Swaziland to South Africa is similar. The special international codes used among countries in East Africa, described in 0, also indicate a special relationship.

Special cross-border codes used to be available around the edges of Switzerland for calls to neighbouring parts of adjacent countries. These have, however, been withdrawn as confusing and not really necessary. Along with some other examples, they could be seen as contravening the intention of

[27] http://www.eto.dk/ETNS.htm and http://www.etns.org/ provide full details. Widespread implementation of routing to +3883 awaits the coming into force of new EU Directives in July 2003.

[28] To achieve its full value, national dialling has to be accompanied by national tariffs. This is notably not the case within the NANP – the cost of calls from the USA to Caribbean codes often comes as a bad surprise.

E.164 where it requires subscribers always to be called “by either the same N(S)N or SN, a national matter, regardless of where the call originated from within the national numbering plan”.

National developments

Basic numbering plan architecture

As was discussed in the introduction, many countries are reviewing and changing their numbering plans. Each country's situation is different, but some general directions of change are clear. The subsections below discuss:

- Estimating and providing required capacity
- Number length and patterns
- Geographic simplification and relief planning

First, this section looks at how to decide the capacity requirements of a numbering plan and then design it to meet those requirements. The most important message is that this exercise is an art, not a science. The need to plan long-term leads to huge uncertainties which often swamp any apparent near-term clarity.

Figure 3 summarises a selection of national numbering plan changes where the NSN length (NSNL) is 7 or more[29]. It is arranged roughly in order of the size of the new numbering scheme (and within equal sizes, by size of old numbering scheme and by country population). Further illustrative material for a few countries may be found in Figure 6.

[29] For an index of available official information on numbering, see the ITU's website at http://www.itu.int/ITU-T/inr/nnp/index.html

Country	Pop'n (m)	Review status	Before change		After change	
			NSNL	Closed	NSNL	Closed
NANP	300	Extra digits after 2025	10	no	12	Yes?
China	1,300	Unknown	10	no	11	no
Germany	82	Ongoing	10/11[30]	no	?	?
Finland	5	Changes 1996	10/11	no	10/11	no
Japan	126	Ongoing	9	no	10	no
UK	58	Changes 1995-2000	9	no	10	no
Italy	57	Changes 1998-	9	no	10	yes
Turkey	64	Changes 1993	8	no	10	no
Argentina	35	Changes by 1999	8	no	10	no
Mexico	93	Changes by 2000	8	no	10	no
France	58	Changes 1985-1996	8, 9	no	9	yes
South Africa	44	Changes 2001-2	9	no	9	yes
Netherlands	16	Changes 1996	9	no	9	no
Sweden	9	Ongoing	9	no	9	no
Switzerland	7	Changes 2002	9	no	9	yes
Spain	39	Changes 1998	8	no	9	yes
Australia	18	Changes 1994-8	8	no	9	no
Chile	14	Under consideration	8	no	?	?
Portugal	10	Changed 2001	8	no	9	Yes
Belgium	10	Ongoing	8	no	9	Yes
Ireland	4	Changes 1998	8	no	9	No
Colombia	40	Changes ongoing	8	no	8	No
New Zealand	4	Changes 1991-2	8	no	8	No
Hong Kong	6	Changes 1995	7	yes	8	Yes
Denmark	5	Changes 1986-94	7	no	8	Yes
Norway	4	Changes 1993	7	no	8	Yes

Figure 3 National number plan changes

Number supply

In theory, a NSN length of n digits yields 10^n numbers. For example, the common NSNL of 8 provides 100 million numbers. But not all of these numbers can be used, for a range of reasons which include:

- Most significantly, structuring the numbering plan so that it provides useful information inevitably leads to inefficiency. For example, the old UK 9-digit numbering plan, with 650 small geographic areas, was exhausted at only 3% utilisation. Administrative units for number allocation (eg to cellular service providers) have a similar effect.

- Some numbers have less than the full NSNL eg typically the 1xx short code range.

[30] 10/11: 10 digits normal limit but 11 in use for private exchanges

- Some numbers cannot be issued because of misdialling risks, especially if they have been used before.

In practice, numbering planners account for such inefficiencies through rough maximum utilisation factors. Typically, utilisation of 40% might be thought reasonable for individual geographic numbering areas. Much lower utilisation factors are likely for entire geographic numbering plans, depending on how many areas there are and of what size. Higher utilisation of 60% or even 80% may be achieved in non-geographic number blocks.

Number demand

These utilisation factors are only rough. But estimating future number demand for a given country is a much rougher exercise still. Plainly, bigger and better-off populations are going to need more numbers than smaller and poorer ones. As network planners know well, predicting lines per head is already difficult enough. Predicting numbers per head is worse, because:

- One line may accommodate several numbers, for example for distinctive ringing tones, DDI, or differentiated information, at very low extra cost.

- Numbers may be used independently of lines, for example in virtual telephony.

ETO guidelines on numbers per person for planning in Europe are reproduced in

Box 5. These guidelines have not been validated even in Europe. Some people feel the guidelines could be on the low side for developed countries, given the rapid take-up of mobiles and new services like efax[31]. There is no reason to expect them to be appropriate for low teledensity countries. The sensible approach for numbering planning in such countries must be to build on a realistic vision of the country's state of development and per capita income in 20 or 30 years' time.

[31] A "virtual fax service" enabling faxes to a number to be delivered without using a fax machine, for example as email attachments.

- A numbering scheme in which the usable geographic space has fallen below **one number per person** is in danger of exhaustion.
- When carrying out changes to the numbering scheme, it is sensible to increase geographic capacity to at least **three usable numbers per person.**
- Countries in which the numbering space available for non-geographic services is **below two numbers per person** should consider a major review.
- A major change should make **at least five numbers per person** available for non-geographic services.
- When fundamentally redesigning a numbering plan, it is reasonable to allow **one** initial digit for **short codes**, **two** for **geographic** numbering and **two** for non-**geographic** numbering, leaving 5 initial digits free for long-term flexibility

Box 5 ETO capacity guidelines[32]

Number length

The obvious answer to capacity problems is just to add a digit, or even two digits, to the national number length. (An extra digit is usually prefixed to the national destination code or to the subscriber number[33]). As each extra digit provides a tenfold capacity increase, it may do away with the need for fine matching of number supply with number demand. However, this solution is not one to be rushed into without careful thought, especially by larger countries or networks which would need 9 digits or more to be dialled for each call, and if their income levels are also low.

Human factors work shows that every extra digit dialled increases errors. In a series of experiments, success rates of reproducing digit strings of different lengths were as follows[34]: four digits 98% correct, six digits 87% correct; eight digits 52% correct; ten digits 19% correct, and twelve digits 2% correct. To look at this another way, 7-digit numbers instead of 6-digit numbers remain within most people's grasp, but each additional digit leads to a less tolerable error rate. When 9 digits per call are reached, most people need memory props such as paper records or electronic devices, which are commonplace in countries with high or moderate income levels, but not necessarily in poor countries (where low educational achievement may make

[32] Source: ETO report on review of national numbering plans on their openness to competition, http://www.eto.dk

[33] But may appear as a new second digit of either code or subscriber number, or indeed of both.

[34] See *The Expanding Telephone Number: Users' Needs for a Common Address Format in Future Converging Networks*, Knut Nordby, available online at http://impcs3.hhi.de/HFT/HFT99/paper99/Future/23_99.doc

matters worse).

At the time of a major number change such as adding a digit, considerable costs are incurred in changing network and customer equipment, manual and electronic records, and user habits. Arguably, it makes sense to add two digits if one is being added – the change cost will not be much affected[35] and the change should last for longer. Some countries appear to have been influenced by this logic, and adding two digits is the preferred option for eventual expansion of the North American Numbering Plan[36]. But for the reasons just outlined, poor countries need to be wary of extra digits.

Figure 3 shows that aside from the world's two "giant" numbering plans (the NANP and China), the capacity of 10 digits is seen as adequate for most foreseeable needs of every other country. (The main exception is that longer numbers are used for Direct Dialling In in some countries, eg Germany). There is a rough correlation between population size and numbering plan size. However, there are exceptions in both directions. For example, Finland for historic and cultural reasons has variable number length of up to 11 digits despite a small population; and France, having used its former 8 digit plan very efficiently, expects 9 digits to be adequate for the indefinite future.

As was mentioned earlier, numbers of standard length and pattern are preferred from both technical and human factors viewpoints. Many countries take the opportunity when changing their plans to move towards greater uniformity, although complete uniformity may not be the best solution. For example one number length may be used in the fixed network and another, longer, one for mobile and/or new services. Standard layouts, such as the NANP's xxx xxx xxxx or the French xx xx xx xx xx, are also found very helpful in reducing transposition errors and misdialling.

Geographic capacity planning

Traditional numbering plans were planned around geographic codes which identified different parts of the country[37]. Another common feature of numbering plan reviews has been simplifying such geographic structures, often combining two or more small geographic code areas into one large one. This is quite a costly exercise but has several advantages:

[35] It may even be reduced if, as may be the case, adding two digits rather than one enables the change to be simpler, while still permitting parallel running of old and new numbers.

[36] http://www.atis.org/pub/clc/inc/nanpe/020107029.doc Industry Numbering Committee (INC) Recommended Plan for Expanding the Capacity of the North American Numbering Plan, December 2001. For an alternative view see *Where have all the numbers gone? Rescuing the North American Numbering Plan from Mismanagement and Premature Exhaust*. Economics and Technology Inc for Ad Hoc Telecommunications Users Committee, June 2000, http://www.econtech.com/library/whatng.pdf

[37] The vast majority of national numbering plans have given their geographic codes some kind of regional structure, so codes with the same first digit are near each other. The two major exceptions to this are the NANP and the old UK geographic numbering plan.

- It is in keeping with underlying network structure, cost and tariff trends (and often also regional company management structures).

- Users like larger local dialling areas, especially if they match local call charging. The package makes up to them for longer local numbers.

- It enables more efficient utilisation of numbers (and can be a useful precursor to introducing local competition).

- Perhaps most importantly, many countries have taken this opportunity to reduce the proportion of their national numbering space occupied by geographic numbers (often from near 100% to 30% or less), thereby creating plenty of space for new services and flexibility for future expansion.

The North American Numbering Plan (NANP) however is going the opposite way and becoming more geographically complex. Exhausted areas are either split or overlaid with new codes. The preferred expansion plan will not simplify geographic structure. The area code map has become impossible to read.

Whether or not a country decides to simplify its geographic NDC structure, it is essential that it look at likely future geographic capacity requirements at the individual NDC level as well as at the aggregate level. It is usually fairly straightforward to identify areas at risk of number exhaustion within (say) the next decade. These are often the larger cities and towns. For each of these decisions are needed on:

- Whether number conservation measures should be introduced, and if so whether change can be avoided for the foreseeable future (this may be possible with very high number utilisation such as will be achievable with full local number portability).

- Whether expansion can be achieved within the existing NDC (normally by adding one or two digits to the subscriber numbers) – if this is the preferred route then an initial digit or two-digit combination must be reserved for the purpose.

- Whether additional NDC space is needed (for an overlay or split) – if so then appropriate NDCs must be reserved for the purpose.

Regular review of geographic NDC utilisation is essential to ensure that relief plans are always in place for areas which may exhaust, and that the planner is not taken by surprise.

While the capacity of a 7-digit numbering plan remains enough for many small countries, it no longer suffices for large conurbations. Several world cities have by now moved to 8-digit local numbers. They include London, Paris, Tokyo, Beijing, Rio de Janeiro and Mexico City. Others which have stayed with 7-digit local numbers (including all large cities of North America) have

been obliged to introduce additional codes. This means either a split of what may be quite a small area (with long-distance dialling between the parts), or an overlay, and an end to local dialling.

Open and closed numbering plans

Here these terms are used as follows:

A *closed numbering plan* has a single dialling procedure for an entire country, and no trunk dialling prefix; it usually though not necessarily has a single uniform number length.

An *open numbering plan* has separate local and trunk dialling procedures, and has a trunk prefix to show when trunk dialling is being used; the lengths of codes and subscriber numbers may vary (though they do not always do so).

Figure 4 summarises the incidence of open and closed numbering plans around the world at March 2002. Traditionally, closed plans have tended to prevail in countries with:

- a relatively small geographic area (eg Hong Kong) limiting the geographic structure needed;
- and/or a relatively small population/number of lines (eg Norway, Denmark);
- and a maximum NSN length of 8 or less, limiting the burden of dialling all digits for every call.

However in recent years many numbering plans (some of them identified in Figure 3) have moved from open to closed, including several with NSN lengths of 9 or 10. To some extent closing a numbering plan has been used to create additional usable capacity, as a substitute for or at the same time as adding a digit (eg congested areas of the NANP, Switzerland). In other cases closing the plan has seemed the only practicable expansion option (eg Italy, Spain).

Maximum NSN length	4 or 5	6	7	8	9	10	11+	total
Open plans	-	1	16	32	30	17	8	104
Closed plans	15	30	25	14	10	1	4	99
% closed plans	100%	97%	61%	30%	25%	6%	33%	49%
Total	15	31	41	46	40	18	12	203

Figure 4 Open and closed numbering plans by plan size[38]

[38] Source: ITU Operational Bulletin 759 Annex on Dialling Procedures, March 2002. This Annex relies on information supplied by countries which is not always in accordance with consistent definitions, so a few discrepancies are inevitable.

Feature	Closed plan	Open plan
Local dialling	Full national number eg 2345 6789	Local number only eg 345 6789
Long-distance dialling	Full national number eg 2345 6789	Trunk prefix + area code + local number eg 02 345 6789
Trunk prefix	Not needed	Needed
Tariff indicators	Early digits of national number	Trunk prefix + area code
Number length	Often one national number length	Can be uniform or variable
Number layouts	Fewer layouts, eg N1+L7[39] and N2+L6 both written XXXX XXXX	Must reflect start of local number, eg 02 345 6789, 034 567 890
Geographic portability	Practicable anywhere	Practicable within code area
Geographic relief	Overlay straightforward	Area split or longer numbers
Long term	Offers great flexibility	Less flexible
Main advantage	Simple for users	Short local dialling
Next advantage	Growth and development easier	Avoids near-term change
Main disadvantage	Loss of short local dialling and local tariff indication	Geographic relief disruptive
Next disadvantage	Users must learn new dialling habits and ways to recognise tariffs	Multiple number formats

Figure 5 Features of open and closed numbering plans

Figure 5 summarises the main features and some advantages and disadvantages of closed and open numbering plans. The examples given are from an imaginary 8-digit plan, and the advantages and disadvantages assume that the plan starts as open.

The main advantages of an open scheme are that customers can dial shorter numbers for local calls, and that geographic area identities are maintained (together with the associated tariff indications). The main advantages of a closed scheme, on the other hand, are a uniform dialling procedure for all calls, and a higher possible capacity utilisation[40]. Also, as there is no need for a trunk prefix, one dialled digit can be saved on national calls[41].

In many larger countries with longer numbers, open schemes remain and may well do so indefinitely. But gradually, as time passes, the balance of advantage moves towards closure:

[39] N1+L7 means a one-digit NDC followed by a seven-digit subscriber number (and so on).
[40] Closure provides an immediate 25% local capacity gain as the ranges starting 0 and 1 can be used for local numbers within each former geographic area.
[41] Although many countries do not take advantage of this potential saving, thinking it simpler for users to dial all digits for all calls, at least for a transitional period.

- a high proportion of calls is in any case dialled with a full national number (often in part because of a rise in calls to and from mobile phones);

- many people use dialling aids (eg memory phones) and so are little affected by the number of digits required for a call;

- there is little difference in cost between a local and a long-distance call, so no effort need be spent on finding out the exact tariffs.

The closure option is one that most countries will want to preserve for the future in case it looks desirable at some time. In practice, this may be most easily achieved by avoiding duplicate use of any first digit both for NDCs and for short codes (so that dropping the trunk prefix will not cause a clash between NDCs and short codes). This usually means avoiding use of 1 to start NDCs.

Longer term, with less differentiated tariff structures and/or alternative ways[42] for callers to find out how they will be charged for calls, a closed plan is conducive to both geographic and service number portability.

Widespread take-up of geographic or service portability will inevitably lead to a loss of meaning in the NDCs in the numbering plan. Ultimately one might see a single pool of numbers which can be used for any purpose in a country, with no meaning in the early digits. A person would be able to keep his number wherever he moved and whatever service he subscribed to. This would have obvious advantages for number "owners" and would also permit a very efficient use of the numbering resource.

Denmark is the country which is furthest down this road, with both full geographic portability and fixed/mobile portability. The only number ranges reserved with special meaning are the international prefix 00, short codes starting with 1, and freephone and premium rate ranges (80, 90) [43]. All other numbers are interchangeable. Before the regulator permitted these developments, market research was carried out to check that fixed and mobile call tariffs were so low, and so similar, that loss of tariff information in numbers was acceptable to callers.

It should not be assumed, however, that this route will be generally followed. Another advanced country, Sweden[44], has recently reviewed its long-term direction for numbering and concluded that it will retain an open plan for the time being. Users like to dial short local numbers and have little interest in

[42] Ways which are not dependent on human interpretation of the number. For example, voice announcements of charge rates during call set-up, a visual display of call cost so far during the call itself, or reference to on-line databases. The topic is covered in a 1999 Ovum report to the European Commission, *Tariff transparency in a multioperator environment,* available at http://europa.eu.int/ISPO/infosoc/telecompolicy/en/tarifftran.pdf

[43] http://www.itst.dk/wimpblob.asp?objno=95024315

[44] Several relevant reports are available in Swedish http://www.pts.se/; English summaries may soon appear.

geographic portability outside their local area. Fixed-mobile convergence is not foreseen for the time being. Compared with Denmark, the additional significant digit (9 instead of 8) means that there are no local number shortages.

Feature	NANP	UK	Sweden	Finland	Chile	Australia	New Zealand
Review position	More codes 1995; major expansion plan being prepared	Extra digit 1995; big tidying up 2000	Review led to no major change	Geog areas reduced from 74 and trunk prefix changed, 1996	Now in progress	Geog areas reduced from 54 and extra digit, 1994-8	Number portability main current issue.
Max geog NSN length	10	10	9	9	8	9	8
Max non-geog NSN length	10	10	10	12	10	10	8
Actual NSN lengths	10	9, 10	7 - 10	5 - 12	8 to 10	9, 10	8
Local competitive integration	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Closure	Creeping	No	No	No	No	No	No
Operator portability	Yes	Yes	Yes	Yes	Under consideration	Yes	Yes
Equal access preselection	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No of geog codes	~230	~650	264	13	24	4	5
1st NDC digits, geog use	2 to 9	1, 2	1 to 9, except 7	1 to 9, except 4 and 7	2 to 7	2, 3, 7, 8	3, 4, 6, 7, 9
1st NDC digits, non-geog use	X00, 8XX	7, 8, 9	7	4, 7; X0	9	1, 4, 5	2, 8

Figure 6 Numbering plans in some liberalised countries

Numbering for competition

As an illustration of the topics discussed in this section, Figure 6 summarises key features of numbering plans in a selection of liberalised countries.

Integrated competitive numbering

Nearly all countries with access network competition (including the NANP) have decided that for both competitive and human factors reasons, all competitors providing fixed network service must share the same set of geographic codes. Otherwise:

- users may get confused by rival geographic code structures,
- new competitors are at a disadvantage because calling them looks as if it is long-distance rather than local, and
- operator number portability (see next section) is hampered.

New entrants will require distinct number blocks within the geographic codes where they provide access. These blocks should preferably be identified by the first digit, of if necessary the first two digits, of subscriber numbers, for two reasons:

- For efficient network recognition and call routing. As mentioned earlier, inbound international traffic, in particular, must be identifiable by the distant gateway within the first 7 international significant digits if it is to be routed differently from other traffic to the same country (eg to a competing gateway chosen by the new entrant). Typically, this allows for a 3-digit country code, 2-digit NDC and the first two digits of subscriber numbers.
- For caller recognition of any higher charges. These may occur in large geographic code areas split into two or more charge groups. They may also occur as a consequence of asymmetric interconnection charging (designed to enhance revenues supporting rural networks)[45].

Similarly, where competitors provide similar non-geographic services, they are allocated number blocks behind the same meaningful codes.

An alternative approach, in which high-level number blocks (typically a whole first digit) are allocated to new operators, is being proposed in some small countries. This approach is normally especially favoured by incumbent operators, and may also be acceptable to second comers as it naturally limits later market entry (to the number of free high-level number blocks). This approach is not generally recommended. It may work long-term in rather exceptional circumstances - if the

[45] Forthcoming publication, Andrew Dymond of Intelecon Research for World Bank.

numbering plan is closed, tariffs are flat, geographic distinctions become unimportant, and few competitors are expected.

Operator number portability

Operator number portability in the fixed network has become a standard requirement in high teledensity countries with fixed line competition. This means that a customer can change to an alternative operator (at the same address) without having to change his number. This obviously makes it much easier for customers to switch operator, and is widely seen as a desirable way to "oil the wheels" of competition. Number portability can be implemented using either call forwarding or some form of database lookup (which may be just for calls to numbers found to be ported, or for all calls). The all-calls database query system is conceptually the simplest but also requires the most advanced network infrastructure (eg full Intelligent Network).

It is worth noting a parallel facility known as "subscriber number portability" which has emerged in a few places (for examples, at one time for mobiles in Eire). This enables a customer to move to another service provider, retaining his personal identification digits but changing the code to that of the new service provider. For example, someone with number 082 123 456 might change provider by moving to number 083 123 456. This is not to be confused with true number portability.

Operator portability has obvious costs (for example, network changes and/or additional transmission for rerouted calls) as well as the benefits resulting from enhanced competition. Cost-benefit studies in high teledensity environments have shown clear net benefits from operator portability within a few years. The position in low-teledensity countries is less clear:

- Other costs or disadvantages may become significant. For example, focusing the incumbent's attention on number portability may distract it from important issues like improving quality of service.

- As there is a large unserved market, competition is less inhibited by the absence of number portability. In fact number portability could have the perverse effect of encouraging new entrants to compete for the incumbent's existing (relatively high value) customers, rather than to provide new lines to unserved customers.

- Substitutes for number portability, such as free changed number announcements, may prove acceptable and cost-effective, at any rate for a period.

Thus, it could be counterproductive to require operator portability in a low-teledensity environment, especially where the technology requires adaptation to provide the facility, and where the current customer base is too small to bear the

initial set-up cost of portability. For every country (or part of a country), there must be a cross-over point, when costs have fallen and teledensity has risen to the extent that operator portability becomes of positive benefit. Exploring these parameters deserves separate study[46].

Operator portability is also of interest between mobile networks and between providers of special services such as freephone/tollfree. Parallel considerations of cost and benefit must be gone through in each case. For example, factors weighing against mobile portability include:

- Customers may be more willing to change their mobile network than their fixed network even if it entails a change of number, if their mobile number is not widely known

- Mobile competitors are often of more evenly matched size and strength than fixed network competitors.

In favour of mobile portability, other points include:

- The networks are usually very up-to-date and the incremental technology cost of the facility should be correspondingly low.

- Mobile network coverage is more likely to overlap than is the case for fixed networks, meaning that customers are more likely to have a choice and therefore actually use number portability.

In most developed countries, mobile operator portability is arriving rather later than fixed operator portability[47]. In the USA, for example, a third extension has now brought the deadline to November 2003.

Factors weighing in favour of freephone portability include:

- Freephone numbers are often widely advertised, so the customer has a strong interest in keeping the number (and the industry in competing for what may be significant revenue streams).

- Full number translation is required for every call in any case, so the additional cost of providing portability is relatively low.

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[46] The author is not aware of any high teledensity countries with competition and without operator portability (or at least plans for it); or, conversely, of any low teledensity countries that have introduced operator portability. The middle teledensity countries of Eastern Europe that are candidates for EU membership are obliged to plan for operator portability. Chile is currently studying the issue, as is Sri Lanka.

[47] Though not invariably. See for example the Irish consultation on introducing portability at http://www.odtr.ie/docs/odtr9901.pdf

In fact, number portability for toll-free service in North America was the first working example of operator portability when it was introduced in 1993.

Countries that currently have low teledensity may not want to require operator portability early in the life of competition. But they would do well to keep the way open for this important development, which often serves user interests, by:

- Ensuring that the numbering plan does not make it hard to have operator portable numbers. In essence, this means having integrated competitive numbering as discussed in the previous section.

- Ensuring that the regulator has the power to impose portability, and decide who is to bear each component of the cost, when it can be shown that it is in the national interest to do so. This may call for a suitable provision in the law and/or in licence conditions. To date there are no examples of operator portability being introduced without a regulatory requirement to do so, although in principle this could happen by agreement in a country with a mature, well-balanced industry[48]. Geographic or service portability use similar network capabilities to operator portability and may or may not arise through market forces alone.

- Encouraging (or requiring) the industry to include number portability in their exchange software as a routine capability, even if it is not enabled; and to allow for future number portability when investing in administration and support systems. This will minimise the eventual cost of introducing portability.

- Regularly reviewing the case for requiring portability of the different kinds mentioned above, separately for fixed, mobile and freephone (or other non-geographic) services.

Carrier selection procedures

Number portability, though it may be desirable, is not essential to the introduction of competition. Some form of carrier selection procedure is however essential if customers are to choose indirect long-distance operators, whether from fixed or from mobile terminals. Various approaches to carrier selection are possible and are discussed below.

Carrier selection means enabling customers to choose who carries their calls (typically long distance and/or international calls[49]), regardless of which access network they are connected to. This may be done call-by-call (dialling extra digits each time to show which carrier is chosen) or by preselection, that is, a

[48] Arguably New Zealand provides an example of operator portability being introduced without a regulatory requirement (as until recently there was no regulator); however government pressure was exercised to this end.

[49] Increasingly, choice of carrier is also being offered for calls to mobiles and even local calls.

one-off choice of preferred carrier[50]. Preselection requires more network adaptation than call-by-call selection, and is often implemented later. When it arrives, it usually comes together with a call-by-call override facility to maintain maximum customer choice.

Regulators normally require fixed network incumbents to implement carrier selection in order to facilitate long-distance competition. Other access network providers may or may not be required to implement carrier selection, depending on a country's telecoms industry structure and policy goals. There may be a trade-off between local and long-distance competition. For example, new access network providers may argue that their ability to choose how to route their customers' long-distance traffic is critical to their viability (and that their customers are happy to have a ready-made choice).

Similarly, when carrier preselection is offered, different decisions are made on its scope – for example, whether customers may preselect different carriers for international and national long-distance calls. Again both competition policy and customer preferences must be taken into account, as must cost recovery. Another important aspect of carrier selection policy is what to do about customers to whom carrier selection is available but who do not make a spontaneous or conscious choice. In some countries, for example Australia, "ballotting" has encouraged every customer to nominate a preferred long distance carrier. In Finland, calls dialled without a carrier selection are allocated randomly among carriers in proportion to all deliberate selections made. Both of these are ways of enhancing the market share of new entrants[51]. In most countries, however, "no selection" defaults to the carrier chosen by the customer's access network (usually, both are the incumbent).

The dialling procedures for call-by-call selection fall into two main categories, illustrated in Box 6.

- *The prefix approach*: carrier selection codes (usually comprising a digit or digits meaning "carrier selection" followed by a short carrier identification code) are dialled as a prefix to the number, which is dialled in full as usual complete with its trunk or international prefix. Any free numbering range can be used for these codes, but the most common choices are the 10XXX range, or other 1YXX short codes. For example, from the UK a subscriber to Superline could dial 1461 0027 11 234 5678 to get low rates to Johannesburg.
- *The insertion/substitution approach*: in some countries, carrier identification codes are inserted after the trunk or international prefix; or alternative prefixes

[50] Usually implemented by the originating carrier adding the carrier identification code to the dialled digit stream.
[51] But may not be immediately welcomed by all new entrants – this depends on their market status (eg second versus later entrant), and readiness to handle and bill bulk traffic.

are used. For example, from Hong Kong a subscriber to New World Telephone could dial 009 27 11 234 5678 to get low rates to Johannesburg.

Box 6 provides some illustrations of codes used with these approaches in a range of countries.

Prefix approach (code followed by normal dialling)
10x range
Austria, Denmark, Estonia, Finland, Italy, Liechtenstein, NANP, Philippines, Poland, Portugal, Slovak Republic, Slovenia, Spain, Switzerland

1yx range (y not 0)
Australia (14x), Belgium (15x, 16x), France (16x), Greece (16x, 17x), Hong Kong (15x, 16x), Hungary (15x), Ireland (13x), Japan (122x), Luxembourg (15x), Malaysia (18x), Netherlands (16x), Norway (15x), Philippines (11x, 12x), UK

Other
Sweden 95xy, Finland 90x

Insertion approach (carrier ID code inserted between prefix 0 or 00 and rest of number)
Carrier ID code types are shown
Bolivia 1x (national, preselection without override available instead)
Germany 10x (national)
Hong Kong x, xx (international)
India 10xx (national, planned)
Japan 7x, 8x (international)
Mongolia
South Korea 8x (national)
Taiwan 1x (national)

Substitution approach (code used in place of all or part of prefix 0 or 00)
Chile: 1xx (national, instead of 0), 1xx0 (international, instead of 00)
Israel: 01x (international, instead of 00)
Finland: 99x (international, instead of 00)
France: first national dialled digit (0 - France Telecom; 2, 4, 5, 6, 7, 8, 9 – other carriers), plus 0 for international calls

Note: x here may stand for any number of digits (usually 1 – 3 but 5 in the NANP); xx, however, stands for 2 digits

Box 6 Choices of carrier selection codes

Figure 7 compares some key features of these two approaches.

The ideal carrier selection procedure from a customer viewpoint is normally preselection with over-ride, as this maximises choice while minimising the trouble of thinking about extra digits and dialling them. This arrangement is also preferred by most new entrants, as it gives them the most flexibility over what

services they can offer and how they can market them. However, as mentioned above, preselection often takes longer to implement than call-by-call selection. Preselection may never materialise in environments with limited competition, or where call-by-call selection is already well established.

	Prefix approach	**Insertion approach**
Number of additional digits dialled	Typically 3 or 4 (eg 1x prefix plus carrier ID digits)	Typically 1 or 2 (carrier ID digits only)
Effect on new (long-distance) entrants	Traffic flow to new entrants can be managed by requiring callers to dial prefix or by network inserting carrier Ids	Can boost traffic to new entrants by forcing callers to dial extra digits (requires extensive publicity)
Exchange implementation	Requires reprogramming at local exchanges	May avoid reprogramming at local exchanges
Ease of use across international and national carriers	High – same dialling procedure	Low – different dialling procedures
Robustness to misdialling	High – normally possible to find a vacant 1x code	Low – carrier ID codes likely to match country codes and may match NDCs
Compatibility with auto-diallers	High – caller drops prefix and dials as previously	Low – caller must learn new dialling pattern
Compatibility with preselection	High – can drop prefix except for over-ride	Low – caller must relearn old dialling patterns (or continue to dial redundant extra digits)
Ease of providing equal access for later entrants	High – relatively easy to provide more codes of same length	Low – very limited supply of ID codes of same length
Flexibility for different access networks	High – robust to omission of prefix	Low – all access networks must use same set of prefixes or risk customer confusion

Figure 7 Comparison of dialling procedures for call-by-call carrier selection

The prefix approach is better adapted to upgrading to preselection, as the prefix can then simply be omitted. As Figure 7 shows, it also has several other forward-looking advantages over the insertion approach. However, when preselection is not available and an alternate carrier is chosen, the insertion approach may result in fewer digits being dialled altogether. This approach was chosen by several countries when expectations of competition were lower than they now are. Sometimes it has seemed attractive because of particular non-standard features of the numbering plan (eg in Hong Kong, the international

prefix was 001 rather than 00, which invited use of 002 etc for alternative international operators).

In summary, most countries that are now introducing long-distance competition should plan for carrier preselection and use the prefix approach for call-by-call carrier selection as an interim measure. The insertion/substitution approach now appears to be a good option only if carrier preselection is a distant prospect[52].

Specific code choices

When changing their plans, countries whose numbering plans do not conform with ITU recommendations usually try to move towards conformity. This means that the international prefix becomes 00, and the trunk prefix (if there is one) becomes 0. Most countries are also moving short codes into the 1XX range. The big exception here again is the NANP, which is and will remain non-conformant, primarily for historical reasons.

Numbering plan change often aims to provide distinctive codes for mobile and specially tariffed services, which will help the public to recognise their characteristics and tariffing. As was shown above, this often means clearing some space formerly occupied by geographic numbers, in order to create a clear difference between geographic and non-geographic numbers. Both geographic and non-geographic services, including mobile, can be found numbered in any range. But the most popular choices for non-geographic services seem to be:

- first significant digit 1 or a late digit (especially 9, 7, or 6 for mobile, 8 for specially tariffed services);

- second significant digit 0 - the X0 and especially the X00 series have often traditionally been left vacant from geographic use. The best example is 800 which has become almost an international de facto standard for freephone services; 900 is also common, although less so, for premium rate services.

Short codes

Using the 1xx range for short codes is a common, though not universal, feature of national numbering plans. In many countries, much of this range is still free, or used in ways which could be changed with little social impact (eg as test codes by operators). For this reason, and because short codes are used for common and essential services, this range has been the focus of many harmonisation

[52] Further reading on this topic includes the 1997 ETO Report on Carrier Selection at http://www.eto.dk/numbering/R3-carrier-sel.htm and a November 2001 OECD report *Carrier selection and preselection* at http://www.oecd.org/EN/longabstract/0,,EN-longabstract-13-nodirectorate-no-4-8448-13,00.html

efforts (see for example Box 2[53] and Box 4).

To date the only widespread success is implementation of the general emergency code 112 in fixed networks across Europe and by GSM networks worldwide. This is also being adopted by an increasing number of other countries. The directory enquiry code 118 is becoming more used, although increasingly it is introduced in an extended form (118xx or 118xxx) to accommodate competitive directory enquiry operations.

Use of 1xx and especially the 10x subrange for carrier selection codes is also common, as is discussed in section 0.

Mobile numbering

		First digit of mobile code												
Region	Country codes starting	0*[54]	0	1	2	3	4	5	6	7	8	9	none	all
Asia	6, 7, 8, 9	2	-	8	2	5	1	9	5	7	4	18	-	61
Europe	3, 4	1	-	1	3	3	3	3	9	6	4	13	1	47
Africa	2	-	3	4	7	1	-	3	7	6	9	16	-	56
America	1, 5	2	-	-	3	2	3	-	6	6	4	8	3	35
world		5	3	13	15	11	5	15	27	25	21	55	-	199

Figure 8 Countries using each first digit to identify mobile[55]

Figure 8 gives an overview of how countries are identifying their mobile networks. This is based on an ITU summary (already nearly a year old) and in turn on possibly inconsistent information supplied by the countries, so its value is at the aggregate level. The figure shows how many countries use each initial digit, or in the case of 0 that second digit, to identify mobile networks[56]. "None" means that mobile networks have no readily recognisable identification: this applies in the USA[57], Canada, Mexico and Denmark. Not having distinct ranges for mobile numbers makes it hard to implement two-tier settlement rates for international calls to mobiles.

[53] In 1998 the ETO prepared an entire report on this subject: *The Harmonisation of Short Codes in Europe*, available at http://www/eto/dk

[54] Refers to 0 being used to identify mobile numbering when in second position, eg in Hungary mobile numbering uses the ranges 20, 30, 60

[55] Source: List of access codes/numbers for mobile networks used with the E.164 country code, Annex to ITU Operational Bulletin 746, August 2001.

[56] No information is available (or there is no mobile service) for about 40 countries, but a similar number of countries use more than one initial digit.

[57] In the USA the caller pays the same to call a mobile as he would to call any other number in the same NPA, and the mobile user pays his service provider the difference in cost to receive the call. This "called party pays" approach tends to be linked with much lower take-up of mobiles.

The following points may be drawn from the figure:

- The vast majority of countries choose to provide clear identification of mobile networks, and well over half of them do so by choosing a specific first digit for the purpose.

- All initial digits are in use to identify mobile; however the later first digits 6 to 9 are more popular than the earlier ones 0 to 5. 63% of countries use 6 to 9.

- The first digit 9 is used the most, by 27% of countries.

- There is little regional pattern to the digits used.

The need for more capacity for mobile numbering is now driving numbering plan reviews in many countries. Underlying take-up is of course growing rapidly. On top of this, the phenomenon of the "throw-away prepaid mobile" and extra services like voicemail are leading to ever greater demand for numbers.

The GSM standard has led to rising popularity of short text messages, and multimedia messaging (which may include images and sound) is on the way. Commercial providers of information and entertainment services are offering new services based on these capabilities – for example, getting updates on a chosen football team's results, or voting for winners in television contests. All these services need numbers, and the nature of the mobile means that short numbers are much preferred. A recent Australian discussion document[58] addresses the issue of providing more numbers for such services.

Specially tariffed services

Number ranges have by now been allocated in most countries for freephone (tollfree) service, and also in many of these for premium rate (value added, shared revenue) service. Rather fewer, but still plenty, have allocated number ranges for shared cost service (local rate or national rate). The overall picture is:

- 800 or 80 has become a practically universal "flag" for freephone services in every country where these services are offered. It is interesting to note that this has happened by market forces rather than by international agreement. In the NANP where 800 started, it has had to be supplemented by 888, 877, 866 and so on.

- 900 or 90 is also widely used as a "flag" for premium rate services where they exist, but this is by no means as universal as 800. Alternative "flags" include 600/60, and additional or alternative codes are used to identify particular

[58] www.aca.gov.au/number/newnumb.htm

categories of service such as televoting and adult services, which people may want to route separately or to bar.

- Shared cost services often use an 8x code but there is a good deal of variation here. Australia uses the 13x range, with 6-, 8-, or 10-digit total number lengths in different subranges.

Other new services

Information on the numbering existing or planned for other new services is somewhat scarce (as indeed are the services themselves, which are often still ideas). General points emerging include:

- Voicemail (and/or virtual telephony) is often numbered as an appendage to mobile service, and is accordingly varied.

- Different numbering solutions are likely for personal numbering (Universal Personal Telecoms or UPT), some at each of local, national and international levels. The code 878 (equivalent to UPT on an alphanumeric key pad) has been suggested for this use, and allocated as the country code for UPT. The first digit 7, especially 70 and 700, is also being used for this purpose.

- Numbering space is being allocated for corporate networks and virtual private networks but there is no pattern to how this is done. In the UK the first digit 5 was provisionally set aside for this purpose and some other countries have followed suit. The implementation of this range is currently under consultation.

- Japan has allocated the 50 NDC for IP telephony.

- Some countries have tried to meet the demand for nationally portable numbers by devoting a range to that special purpose. This is similar to a specially tariffed “national rate” range.

- In many countries special codes, sometimes short codes, are provided for internet access. Again there is no pattern to the choices made.

- There is a case for providing a special range for numbers used for access to alternative operators, in case these need to be barred (for example, as a condition of getting a cut-price tariff from the incumbent).

Part of numbering or dialling plan used for new services

In open plans, there is significant variation as to whether national NDC space,

short code (1xx) space or local subscriber number (SN) space is used for any particular service type. The most common choice is NDC space, though short code seems to be increasingly used, possibly because it is the most readily available source of free codes. SN space is the least common option.

There is no one right answer to which part of the numbering or dialling plan to choose for any given purpose. The following general points may be helpful.

- 1xx code space is often inaccessible from abroad. This has to be the case in open plans unless care has been taken to avoid any duplication between the 1xx range and the 01xx NDCs (as is true in Australia).

- Some countries argue that short code space is a scarce resource which should be reserved for memorable codes for special services of public interest. In general new services need long numbers and would not qualify. The Netherlands has elaborated this line. Australia has chosen the opposite approach and put most of its new services into 1xx space.

- The choice between SN and NDC space will be influenced by whether it is convenient to provide service at the local or national level. The local choice is a minority one for services like freephone which potentially have national reach, but it has been made, for example in Bolivia where local numbers starting 800 are used for freephone. Local numbering is a natural choice for a customer-linked service like voicemail

- Charging implications must also be borne in mind. Customers may believe that 1xx calls are uncharged or low charged, and if this is not so then they should be warned. This may be one reason that freephone quite commonly appears in 1800 space, while premium rate services are usually found in NDC space (eg 0900).

- For internationally harmonised applications, 1XX space may well be the easiest option. SN space will be the hardest, as it will be hard to find SN ranges that are clear even throughout a single country, let alone in several countries whose numbering plans have evolved independently.

- Where short code space is used, the issue arises of how special services provided on one network may be accessed from a different network. A familiar example of the need for this is trying to report an out-of-order line, which obviously cannot be done from the line in question. To give a concrete example, a mobile network with numbers 082 xxx xxx may provide the short code 123 for its customers to report faults. This cannot be accessed directly from other networks, but any or all of the following alternative access options may be provided instead:

    - 082 123 (blocking 1,000 potential subscriber numbers)

- A freephone or other specially charged number, such as 0800 082 123
- A carrier selection prefix, eg 1082 123
- A shared industry fault reporting short code (say, 124) with carrier-specific extension, resulting in the sequence 124 082

The regulator and numbering

There is understandable reluctance from some incumbents to relinquish control of the numbering plan, and often a matching hesitation from regulators to take on this role, for which they may feel ill-resourced and unready. However, there is very widespread agreement that:

- the national telephony numbering plan is a national resource;
- it should be managed in the overall national interest;
- in a competitive environment, the regulator needs to make sure that this happens.

It goes without saying that to function properly the regulator must be independent from both the government and the industry, although naturally consulting fully with both.

A prime regulatory role is resolving conflicts of interest. There are plenty of these in numbering, for example:

- the incumbent is unlikely to be eager to share numbering resources fairly with new competitors, or even to reveal its existing usage of number blocks;
- network operators may want to use numbers for "branding" their services, while users want a simple, uniform scheme where the identity of the operator is subordinate to the geographic or other significance of the NDC;
- business users may prefer a closed scheme while residential users want to retain local dialling.

Duties of the regulator

Luckily (given common resource problems), the regulator does not need to take on all the day-to-day chores of running a numbering scheme. But there are certain tasks that he cannot avoid. He must at least:

- maintain a long-term vision for the numbering scheme and resist short-term pressures which may lead to dead ends. This means he must foresee potential capacity shortages, instigate a review when necessary, and take overall responsibility for the choice of scheme architecture in the national interest.
- regularly consult all interested parties, acting himself as guardian of the user interest. This means he must ensure user views are found out and taken into

account; especially at review time, give user views due weight; and ensure the right notice periods and publicity for any changes.

- decide on and make public the basic rules governing the use of the numbering scheme, including number structures and lengths; number ranges to be used for particular purposes or reserved, taking account of movements towards international harmonisation; and how numbers will be allocated to telecoms operators - especially new competitors.

- administer the scheme at the top level in a competitively neutral way. This means allocating number blocks to network operators while observing the principles of good husbandry. Generally this boils down to granting capacity to meet bona fide demand (allocating modest size blocks while reserving others nearby for expansion), while retaining the ability to withdraw unused or badly used number blocks.

- set rules for allocation and, if permitted, trading of scarce (premium or golden) numbers or number blocks, including any charging or auction mechanism designed to ensure that numbers go to whoever values them most highly.

- set the rules governing other competitive issues with numbering implications, in particular carrier selection and operator portability, those relating to the production of telephone directories, and the running of necessary number databases (sometimes on a shared industry basis);

- resolve any disputes.

Other numbering plans

The difficulty of managing E.164 numbering plans is a result of three factors coming together:

- these numbers being the user interface to the network;

- potential shortages;

- the possibility of access to numbers being a source of unfair competitive advantage, with the incumbent in a favoured position.

Many regulators also manage non-telephony numbering plans on behalf of their country – for example, Signalling Point Codes, International Mobile Station Identities (IMSIs)[59], and in some cases IP addresses and internet domain names. Only the last of these, internet domain names, has a user interface, and only IP

[59] See ITU-T Recommendation E.212

addresses and IMSIs show any signs of possible exhaustion. Domain names are managed by a variety of bodies in different countries, including academic or industry groups.

An Ovum Strategic Numbering Review carried out in 1998-9 for the Dutch regulator[60] looked at a wide range of numbering, naming and addressing schemes and concluded that the Dutch government should focus its research on E.164 numbering, IMSIs, IP addresses and internet domain names. Of these, E.164 was the only scheme recommended for government's overall control. A recent Norwegian report[61] on managing the .no top level domain however concludes that ultimate responsibility for .no should rest with the government (and be exercised by the telecom regulator), even if operations are delegated to another body (currently the industry body NORID).

Some of these functions are explored in more detail below. The next section touches on some legal aspects that may need to be resolved early in setting up a new numbering regime.

Some legal aspects of numbering

Generally the legal status of numbers and their "ownership" is unclear. It is very helpful if any new telecoms legislation or regulations can establish a system of rights and obligations which achieves something on the following lines:

- overall national *ownership* of numbers, enabling the regulator to control use of the numbering plan in the national interest, subject to the usual requirements on consultation and transparency, while delegating day-to-day administration to network operators. It is also wise to enable the regulator to "hive off" aspects of numbering scheme management as they become routine, perhaps to an industry body under the regulator's ultimate supervision.

- *Allocation* (rental) to network operators and maybe service providers, possibly under the aegis of a licence condition. Allocation will be subject to reasonable conditions on the correctness and intensity of use of the allocated blocks, and will include the regulator's power to charge for the numbers and to reclaim the space if necessary.

- *rights of use*[62] by service providers and end customers, subject to the regulator and/or network operator retaining any desired control of golden numbers and number trading, and the ultimate right to change individual

[60] Available online at http://www.minvenw.nl/dgtp/home/publicaties/fr_publicaties.htm
[61] Model for the management of the Norwegian Domain Name Administration and the resolution of disputes, Report by the Working Group on Domain Names, March 2002

[62] This topic has been most fully explored in Australia. Oftel's relatively simple current draft is at http://www.oftel.gov.uk/ind_groups/numbering/wg1/rgu0100.htm#Rules

numbers or make general changes in the scheme if the national interest requires this.

- a clear understanding of *intellectual property* in particular numbers or number ranges, and in the numbering scheme as a whole, in order to prevent the misappropriation of some aspects of the scheme by some operators or powerful corporations.

- Recent years have seen considerable debate in the developed world around the topic of *trading* in individual numbers. No real solutions have yet emerged, though lotteries and auctions for valuable numbers have both been considered[63]. A recent consultation paper from Hong Kong[64] puts forward some useful proposals, taking account of developments in other countries (which are summarised in an annex). Box 7 reproduces the proposed principles underlying OFTA's approach.

All these topics become of special importance when they relate to "golden numbers" (which have attractive or memorable digit patterns, such as 0800 800 800) or alphanumeric numbers such as 1 800 FLOWERS (where the letters appear using a standard mapping on numeric keypads).

Individual allocation of golden numbers, whether to service providers as in the USA or to end users as in several European countries, is the subject of continuing debate. As it requires routing to a user whose network is not identified on the face of the number, it calls for technical changes which are closely related to those needed for number portability, and similar arguments about costs and benefits arise[65].

[63] See for example *A new allocation system for valuable telephone numbers?* ACA Public Discussion Paper, December 2000.
[64] *Special number arrangements*, OFTA consultation paper, June 2002.
[65] See for example Oftel's recent proposal to change the framework for number portability in the UK at http://www.oftel.gov.uk/publications/numbering/2002/nupo1202.htm.

Guiding principles

In drawing up the implementation details for Special Number Arrangements, the Telecoms Authority proposes to adopt the following set of basic guiding principles:

- employ a fair and transparent procedure;
- promote efficient use of numbers and codes;
- obtain market value for attractive numbers and codes;
- allow for, and encourage recovery and reallocation of unused, or no longer required, numbers and codes;
- allow for the allocation of numbers/codes only where there is a legitimate need or intent to use the numbers and codes for the purpose of telecommunications services;
- on the one hand seek to minimise windfall gains through numbers/codes and prevent the inflation of the price of numbers/codes due to artificial scarcity, and on the other hand ensure that each number/code can be allocated to the user who places the highest value on it;
- NOT unduly add complexity to the allocation system;
- NOT encourage number/code hoarding; and
- NOT give unfair competitive advantage to any operator or customer.

Box 7 Principles proposed by OFTA for special number arrangements

Prudence and good husbandry

Some basic principles of numbering planning are obvious but may be worth restating:

- Change is expensive: think long-term so as to minimise changes.

- Keep your options open for as long as possible, until one course of action is clearly right.

- The customer's interest is the national interest (there is no serious conflict with the industry interest).

Some guidelines for numbering good husbandry follow immediately:

- Keep the incumbent to number blocks that are already in use. If more blocks are needed, they should make a case for them just as a new entrant would.

- Allocate numbers to operators in blocks of modest size (eg 10,000 numbers), reserving capacity for foreseeable growth in adjacent numbering space.

- Retain the ability to reclaim under-used numbering space.

Charging for numbers

A sound economic case[66] can be made in favour of the number administrator

[66] See for example the 1995 OECD report *The economic and regulatory aspects of telecoms numbering* at http://www.oecd.org/pdf/M000014000/M00014292.pdf. The UK debate in 1998-9

charging for number allocations. The case may include the following elements:

- Covering the administrator's operational costs of managing numbering resources, where these are not already funded by another route.

- Encouraging care in use of the resource. Charging can be a valuable tool where number conservation measures are in force, with the aim of postponing code exhaustion and the need for relief.

- Reflecting the inherent value of the numbers in the allocated block. This is especially relevant for freephone and specially tariffed numbers, where operators sometimes make windfall gains by charging customers for golden numbers which they obtained without payment.

Arguments against charging for number allocations include:

- The perception that this is a "tax" which will increase overall burdens on the industry and ultimately on end-users.

- Given that operational costs per number should be low, the effort involved in calculating charges, and in billing and collecting amounts due, may outweigh the available benefits, especially where there is no shortage and golden numbers are not an issue.

- In the USA, a concern has been voiced that the payment of charges for numbers may lead to a presumption of ownership of the numbers in question, when in reality they remain public property which the allocatee is permitted to use. This argument has been deployed against legalising trading in individual numbers, but has not prevented administrative charging.

A reasonable conclusion may be that countries should consider their position in relation to charging for numbers, allow for it in their legislation, and be ready to introduce charging in number ranges where this appears to be in the public interest. When charges are introduced, it may be appropriate to make compensating adjustments to other payments (such as licence fees).

Figure 9 provides as illustration the annual charges currently being made in some European countries for ordinary telephone numbers and for carrier selection codes[67]. EU regulations (which either apply now or will soon apply to

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can be followed through Oftel's consultation on Developing Numbering Administration at http://www.oftel.gov.uk/publications/1995_98/numbering/dna798.htm and its statement at http://www.oftel.gov.uk/publications/1999/numbering/frdna599.htm

[67] Information on number charging in Australia is available at http://www.aca.gov.au/number/numbchrg.htm. The annual charge for an ordinary phone number is around AU$1 (within the EU range). The charges for longer and shorter numbers are related to this logically, as in Denmark.

all these countries) permit but do not require cost-based charging. Points worth noting from this Figure include:

- Many European countries are now making charges, but many others are still not doing so (most European countries not listed here are making no charge, though Germany makes initial but not annual charges).

- The levels of charge vary significantly, but even the highest are low compared with the relevant revenues.

- In Denmark, there is a logical relationship between the charges for numbers of different lengths (a 4-digit carrier selection code occupies 10,000 times as much numbering space as an 8-digit telephone number and costs 10,000 times as much).

Country	Annual charge for ordinary phone number (in euro cents)	Annual charge for 4-digit[68] carrier selection code (in euros)
Belgium	1.34	13327
Bulgaria	10	13049
Czech Rep	3	684
Denmark	25.71	2571
Estonia	153	3835
Finland	34	18000 (international), 9000 (national)
France	2	40000
Greece	2.5	15000
Hungary	27	5395
Italy	1.1	54598
Lithuania	5	1227
Luxembourg	12	1239
Netherlands	0.16	225
Poland	7	1300
Slovakia	5	451
Slovenia	11	440

Figure 9 Examples of number allocation fees in European countries[69]

Transparency and consultation

The national numbering plan is common property. The plan itself, any rules

[68] May apply to other code lengths in some instances.
[69] Sources: Eighth Report from the Commission on the Implementation of the Telecommunications Regulatory Package, Annex 1, Table 3, Brussels, December 2002, at http://europa.eu.int/information_society/topics/telecoms/implementation/annual_report/8threport/index_en.htm; 2nd Report on Monitoring of EU Candidate Countries (Telecommunication Services Sector), Annex 1, Table C, Brussels, December 2002 at http://europa.eu.int/information_society/topics/telecoms/international/accession/index_en.htm

relating to it (often referred to as “numbering conventions”) and allocations from it should be clearly documented and a matter of public record[70]. The internet now provides an excellent vehicle for making such materials widely available, and many of the world’s regulators are taking advantage of this[71]. Documentation and rules about numbering plans can amount to a large body of material. Box 8 and Box 9 illustrate this – they outline recommended content for numbering rules. Australia’s current Numbering Plan alone is a document of nearly 300 pages.

National Regulatory Authority (NRA) responsibilities
- national numbering plans should be controlled by an NRA and their administration should be carried out by an NRA or another independent body
- the national numbering plans should provide sufficient capacity, enable fair competition and be in line with ITU-T Recommendations
- the management of the national numbering plans should be controlled by an NRA
- the management should be carried out in an objective, non-discriminatory, equitable, proportionate, timely and transparent manner.

Consultation, publicity and appeal by NRAs
- the NRA should consult market parties on important numbering conventions issues and large-scale withdrawals of assigned numbers.
- Information should be appropriately published regarding the national numbering conventions, primary assignments by the Numbering Plan Manager (NPM) and the status of each number
- publicity of a change in a substantial part of the active national telephone numbers should be well co-ordinated and started well in advance
- appropriate appeal procedures should be laid down.

Box 8 Summary of proposed ETO harmonised numbering conventions - general

[70] Subject only to limited exceptions on grounds of commercial confidentiality. This is only likely to apply to number blocks reserved (not allocated) for new services which have not yet been announced.
[71] Good examples include Australia http://www.aca.gov.au/number/index.htm, Switzerland http://www.bakom.ch/en/telekommunikation/nummerierung/index.html (in four languages), UK http://www.oftel.gov.uk/ind_info/numbering/index.htm. The NANP and Hong Kong are also excellent sources of relevant material, but the websites in question are less easy to use.

Applications for primary assignment
- eligible applicants should be defined
- the information required for the Numbering Plan Manager to decide on an application should be defined

Primary assignment and the choice of numbers
- the principle of 'first come, first served' should be applied, except when starting assignment from newly designated number ranges
- applicants should have the right to indicate their preference for specific telephone numbers
- users should have the right to use telephone numbers that are not frequently misdialled.

Timescales for decision on applications for primary assignment
- the time limit between receipt of an application and notification of the decision on the application should be laid down
- the applicant should be informed by the Numbering Plan Manager as soon as possible on receipt of the application.

Refusal of primary assignment
- the applicant should immediately be informed about a refusal, its reasons and the procedure for appeal against the refusal
- refusal should only be allowed for a limited set of reasons which should be laid down.

Usage conditions after primary assignment
- assignment should only imply the granting of rights of use
- the legitimate purpose of usage of assigned numbers should be laid down
- the time limit for activation should be laid down
- the assignee should provide information on usage to the Numbering Plan Manager
- fees should seek to cover the administration and management costs
- transfer of assigned number is prohibited so long as no appropriate regulatory framework for number trading has been put in place
- the assignee should not use network-specific telephone numbers that may cause interference with the national telephone numbering plan.

Withdrawal of numbers from assignees of primary assignments
- withdrawal should only be allowed for a limited set of reasons which should be laid down
- the overall societal costs of a withdrawal should be carefully considered
- the procedure for a withdrawal should allow an assignee to clarify its position before a decision is taken
- when a change of active telephone numbers is imposed, the users of these active numbers should have the right to have disruption minimised.

Conditions for secondary and tertiary assignment
- secondary and tertiary assignment should comply with the national numbering plans
- the usage conditions for primary assignment should also apply regarding the granting and transfer of rights of use and the right of users to have disruption minimised because of a number change

Box 9 Summary of proposed ETO harmonised numbering conventions – assignment

Exactly what rules are needed for successful numbering management and administration in any given country will depend on its legal and regulatory framework and local competitive and social conditions. Many countries will find a short and simple collection of rules enough[72]. The headings in the ETO summaries may be useful as a checklist of topics to be covered.

Regulators in many countries have set up Numbering Advisory Committees[73] and found them useful. These comprise industry experts and sometimes also user representatives and/or independent experts such as academics. Not only are these bodies a source of numbering expertise, but they may also be helpful in making unwelcome changes politically acceptable. A few years ago Oftel responded to charges of "closed doors" by replacing its long-standing Numbering Advisory Group, which consisted of invitees only, by an open Numbering Forum[74].

Planning a major numbering change

Finally some guidance is provided for the regulator who has decided to embark on a numbering review or is already committed to major change.

Numbering options

A systematic approach to a numbering review will entail:

- defining a range of options to be considered. This should cover all sensible possibilities;

- listing the criteria to be used for evaluating the options; these will be heavily based on the customer and industry requirements mentioned above, and will also include the regulator's own requirements such as ease of management.

- evaluating the options against the criteria[75]. Taking account of the importance of the criteria, this should lead to an apparent "winner" and probably one or two plausible "runners-up";

- subjecting this result to common-sense criticism. In many countries this will be achieved by wide circulation of the material in an industry and public consultation.

Absolute requirements of all numbering options include:

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[72] Such as Tanzanian provides at http://www.tcc.go.tz/Guidelines_numbering.htm, http://www.tcc.go.tz/Regulations.htm and http://www.tcc.go.tz/Numbering_scheme.htm.

[73] Interesting websites include http://www.aca.gov.au/committee/national/nac/nac.htm and http://www.ofta.gov.hk/ad-comm/nac/nacpaper.html

[74] http://www.oftel.gov.uk/ind_groups/numbering/forum/nofrm.htm

[75] A 3-point scale (good, acceptable, poor) will usually suffice. The purpose of this exercise is to clarify thinking, not to attempt unattainable precision.

- providing adequate numbering capacity (in both quantity and quality) for all foreseeable needs for the chosen planning period;

- being evolutionary, not revolutionary - ie being realisable through a step-by-step migration path from the status quo;

- long term flexibility.

In addition, the capability to run old and new number plans in parallel for a period, during which misdialled calls can easily be trapped, is highly desirable. This is normally achieved by using different numbering ranges for old and new numbers. For example, if the first digit 2 is unused, then it can be used as a prefix to old numbers. The system will immediately recognise whether an old or new number is being dialled from whether or not the first digit is 2. However, if some old numbers start with 2 then this clarity is lost.

In deciding on the best option, it is important to keep a proper balance between long-term and short-term considerations. Some countries have allowed the migration process itself to dictate the shape of the new plan. An easy migration is very desirable, but it only happens once. The plan that it leads to will be in effect for many years. It may be worth a more costly transition to have a lasting better plan in place, with beneficial effects on callers and the industry.

The timing of change

The timing of change is itself a big decision. In high-teledensity countries there is usually a desire to delay change for as long as possible. This can often be justified by cost savings. Technical change means that change costs may be lower in future, and even if they are not, the time value of money points to postponing change. The NANP is a good example. Although expansion plans are being formulated, their implementation date is always a good ten years in the future and some people believe they will never be needed. Meanwhile there is a drive to put in place number conservation measures such as rate centre consolidation (the simplification of charging areas) and number pooling (allocating numbers to operators in 1,000 number blocks instead of 10,000 number blocks)[76].

Low teledensity countries, on the other hand, especially if they are small, may be better served by changing their numbering plan sooner rather than later, if a change is demonstrably needed. The bulk of change costs usually fall on customers rather than on the industry. Where the customer base is growing rapidly, it may be better to implement number plan change soon.

[76] http://www.nanpa.com/pdf/intro_numbering.pdf provides a simple introduction to the NANP, including an overview of these complex topics.

Implementing a major numbering change

A big numbering change is itself a major management challenge. Assuming the decision on the chosen option has been made, decisions may yet remain on practical details such as whether the change should be all at once ("big bang") or in stages. A "big bang" may be simpler to publicise and more straightforward for the public; on the other hand, a staged change has a flatter resource profile and implies less commitment to precise dates. Also, with complex changes, staged changes may be easier for the public to assimilate.

A regulator's checklist of implementation requirements would include considerations such as the following. The regulator's role in implementation would normally be confined to top-level oversight to ensure that everything is going to plan, and where appropriate assisting with public relations, including providing justification for the change. It would not include meeting any substantial cost s of change – those are met where they fall, unless the industry agrees otherwise (for example by carrying out jointly-funded publicity campaigns).

Network operators[77] must be sure to:

Implement the right changes to exchanges of different types. This sort of programme cannot be implemented overnight - it must be gradual to avoid unacceptable risk of network failure. It must include changes to Calling Line Identification functions as well as to number recognition, charging and routing functions.

Implement recorded announcements for misdialled calls.

Make changes to operational support systems (eg directories, any computer system holding telephone numbers).

Ensure matching changes at international exchanges by overseas correspondent administrations[78].

For the general public, it is necessary to:

Obtain political assent to the change.

Provide advance publicity of the change both to people with phone numbers (who may need to change stationery, signs, vehicles etc) and those who call

[77] An excellent overview of BT's handling of recent changes in the UK is given in *National Code and Number Change – Technical Solutions for BT's Network*, by Beatrice Osborn and others, The Journal of the Communications Network vol 1 part 1 April 2002, pp 107-113.

[78] A forthcoming new ITU recommendation (E.129) will set out strategies for communicating numbering plan changes to network operators around the world.

them (who may need to change records in databases etc as well as personal habits). Publicity must be far enough but not too far ahead (diary publishers usually need information two years ahead).

Plan a period of parallel running, to enable large business systems to be reprogrammed gradually.

Provide support for changes to customer premises equipment, especially payphones and automatic alarms.

Reference section

Further reading

The footnotes to this paper already provide many references to relevant published sources. This section provides selected additional general references. In addition, most national regulators' websites and many network operators' websites include useful material on numbering.

Online numbering course provided by ITU's Asia-Pacific Office and ACA
http://www.getit-multimedia.com/itu_aca/

Introductory material on numbering provided by NANPA
http://www.nanpa.com/pdf/intro_numbering.pdf

Privately run sites providing information on national numbering plans
http://www.numberingplans.com/
http://www.wtng.info/

ITU page linking to information on national numbering plans
http://www.itu.int/ITU-T/inr/nnp/index.html

ITU Study Group 2 home page
http://www.itu.int/ITU-T/studygroups/com02/index.asp

Set of links on number portability
http://www.ported.com/world.htm

List of abbreviations used

ACA	Australian Communications Authority
ETNS	European Telephony Numbering Space
ETO	European Telecommunications Office
EU	European Union
GSM	Global System for Mobile Communications
ID	identification
ITU	International Telecommunications Union
NANP(A)	North American Numbering Plan (Administration)
NDC	National Destination Code
NRA	National Regulatory Authority
NSN(L)	National Significant Number (Length)
OECD	Organisation for Economic Co-operation and Development
OFTA	Office of the Telecommunications Authority (Hong Kong NRA)
Oftel	Office of Telecommunications (UK NRA)
SN	Subscriber Number
UPT	Universal Personal Telecommunications