FINAL REPORT

ON
NUMBERING RELATED TO
PERSONAL COMMUNICATIONS SERVICES (PCS)
IN EUROPE

7 November 1997

This study has been prepared by ETO on behalf of ECTRA for the Commission of the European Union.

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This report has been prepared by Gerd Wiedenhaupt and Jukka Kanervisto of ETO with the kind assistance of the experts of the ECTRA Project Team on Numbering, ECMA, ECTEL, ECTUA, EIIA, ETNO, ETSI and GSM MoU EIG. It is to be noted, however, that the report does not necessarily reflect the official opinions of the said organisations.

EXECUTIVE SUMMARY

This study on "Numbering related to Personal Communications Services (PCS) in Europe" has been prepared by ETO on behalf of ECTRA for the European Commission.

The purpose of this study is to examine how Personal Communications Services (PCS) should be numbered in a European context.

Two main concepts exist on personal telecommunications services: PCS and UPT (Universal Personal Telecommunications). The concept of PCS was originally developed by the mobile industry in order to allow people to use "Phones on the Move". The other concept is UPT, which has been developed mainly by the fixed network industry. The ultimate aim of both these concepts is to allow personal telecommunications services with one single Personal Number (PN) which can be used instantaneously in all kinds of networks, fixed or mobile. In these concepts, the personal number is separated from the physical network address. To reach the called party, the personal number has to be translated into a physical network address.

In this study, ETO has considered a number translation facility - ultimately IN-technology - as one prerequisite for personal numbering. Inversely, in all IN-based services, the access number is separated from the network address, and personal numbers may develop from any non-geographic IN-based services. The difference between personal numbers and numbers of IN-based services has to do with their objectives. The aim of personal numbers is to facilitate person-to-person communication, with the ultimate possibility of instantaneous mobility of the called party, while the aim of IN-based services (e.g. Freephone) is location-independent service provision rather than person-to-person communication. In IN-based services, instantaneous mobility is not necessarily needed.

In mobile networks, mobile subscriber numbers are already separated from the physical network addresses of the mobile terminal. There are no major technical constraints on the use of mobile numbers as personal numbers. Number portability of mobile numbers between mobile operators is under consideration in Europe. The possibility of mobile subscribers to change their mobile network operator without changing their number and the possible use of mobile numbers as personal numbers may facilitate competition and offer new business opportunities in the telecommunications market.

In the fixed network, geographic subscriber numbers are at the same time also physical network addresses - no separation exists between access number and physical network address. The use of geographic subscriber numbers as personal numbers implies an extensive introduction of IN-technology. Therefore, this alternative is not considered feasible in the short term.

A demand for personal numbers has already been recognised at the national level. It is also estimated that the overall demand for personal numbers will grow extensively in the future, to up to 25 - 50% of the total number of inhabitants. For the total of all European countries, this means up to 300 million personal numbers. However, the need for Europe-wide personal numbers is unclear. There may be some Europe-wide demands, for which personal numbers from national resources will be too limited; though, no clear market demand for such pan-European personal numbers has been identified so far.

At the global level, UPT numbers are reserved only for the UPT service. Personal numbers that do not meet the UPT service definition cannot be numbered from UPT number resources. No other number range for personal numbering exists at the global level. European Telephony Numbering Space (ETNS) is being created to promote Europe's own service provision - whatever the service involved. Although no clear market demand for European personal numbers can be observed at the moment, the possibility of having this demand in the future can not been discarded. ETNS should provide resources for European personal numbering, if it is needed.

Separate non-geographic number ranges should be reserved for personal numbers. This is the case in some countries, where number ranges for personal numbers have already been allocated. In these countries, number ranges starting with the digit 7 are most commonly used for personal numbers.

With regard to personal numbering, ETO makes the following proposals:

1) Number resources for national personal numbers should be reserved by using one or more separate NDC ranges from the national numbering scheme. In order to allow for an easy recognition of personal numbers by users, the use of NDCs starting with the digit 7 should be preferred.

2) The number range reserved for personal numbers should be used for all types of personal telecommunications services in which the focus is person-to-person communications.

3) Personal numbering may develop from any IN-based services. Dedicating a separate number range to personal numbers should not prevent these IN-based services from developing in their own number ranges.

4) The ETNS should provide resources for European personal numbers when needed. In order to allow easy recognition of European personal numbers in the future, ETNS number range 7 - as particularly appropriate for European personal numbers - should not be allocated to other services.

1.   Presentation of the Study

This study on "Numbering related to Personal Communications Services (PCS) in Europe" has been prepared by ETO on behalf of ECTRA for the European Commission.

It has been estimated that at the beginning of the 21st century, up to 50 percent of all subscribers will be using one of more services that are mobile. This phenomenal growth in mobile services makes it necessary to consider the question of how existing fixed networks and new mobile networks can work together. This question should be posed in particular with regard to new services and concepts, which are currently breaking existing national boundaries. Personal Communications Services is one of these concepts.

The work order (Annex A) addressed to ETO by the European Commission is as follows:

1) to analyse present visions of the future development of telecommunications networks and services and to assess their effects on numbering and addressing;
2) to examine Global / European Issues on personal numbering and demands on European numbering. Regarding the implementation of Personal Communications Services within Europe, to highlight the issues to be taken into account when developing a European numbering strategy;
3) to combine the findings of this report with the proposed strategic options[1] and to make proposals for the numbering of Personal Communications Services in Europe.

The first interim report was delivered to the Commission, ECTRA, the ECTRA Project Team on Numbering and the ENF[2] for their comments in July 1995 and the second interim report in September 1996.

Interim reports were discussed in the ECTRA PTN and the ENF. These parties have also actively contributed to ETO during the work. Based on the interim reports, a workshop was held to elaborate the framework of PCS and final demands for personal numbering.

The draft final report contained the ETO findings and proposals and it has been sent to ECTRA, ECTRA PTN and the ENF in June 1997. The final report, as approved by ECTRA in December 1997, includes any comments which individual CEPT/ECTRA members have on these issues with regard to their respective national regimes. Comments from ENF members, which arose during the consultation process in the ENF, are included in the report. The final report will be delivered to the Commission after ECTRA's approval.

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[1]   Consultation on Strategic options for numbering of telecommunication services in Europe 27 July, 1994

[2]   The European Numbering Forum (ENF) was established as a Forum for the exchange of information and expertise, co-ordination and consultation, discussion and common studies on European numbering, addressing and other related issues, in accordance with European Union Council Resolution 92/C318/02 on the promotion of co-operation on numbering of telecommunication services throughout Europe. Currently participating in the ENF are the following European organisations (in alphabetical order): the CEC (Commission of the European Community), ECMA (Standardising Information and Communication Systems), ECTEL (The European Telecommunications and Professional Electronics Industry), ECTRA (European Committee on Telecommunications Regulatory Affairs), EIIA (European Information Industry Association), ETNO (European Public Telecommunications Network Operators' Association), ETSI (European Telecommunications Standards Institute), GSM MoU EIG (GSM MoU European Interest Group) and INTUG Europe (International Telecommunications Users Group)

2. Background

The development of the telecommunications sector in Europe is based on a strong support for competition[3]. The last few years have been characterised by an extensive growth in mobile services, e. g. GSM and paging. Mobile services in this context mean the use of all kinds of existing mobile services, e.g. DCS1800, GSM, DECT technologies and future services, e.g. UMTS, FPLMTS, S-PCS, CTM, as well as other services which allow geographic portability by using non-geographic numbers. Within the same time frame, the number of subscribers to fixed networks has increased only slightly. This phenomenal growth in mobile services makes it necessary to consider the question of how existing fixed networks and new mobile networks can work together. This question should be posed in particular with regard to new services and concepts, which are currently breaking through existing national boundaries. Personal Communication Services (PCS) is one of these new concepts.

Although the term PCS is often used today, there is no unique definition or single understanding of this term (Annex B). During the preparation of this study, it became clear that in order to find solutions for PCS numbering, it is necessary to have a clear understanding of what PCS really means in the national and in the European context.

2.1 Personal Communications Services (PCS)

The concept of PCS was originally developed by the mobile industry to allow personal mobility[4] and terminal mobility[5], to allow people to use "Phones on the Move". This implies some form of wireless user-interface to the network. PCS is considered by the mobile industry to be an umbrella for wireless network access. It should offer mobility through a variety of different technologies, e.g. GSM, DCS1800, DECT, GMSS or S-PCS and the present goal is to extend it to the fixed network. PCS will be seen as a service rather than a network (Annex G).

At present, a number of different definitions of PCS exist which can generally be divided into two groups. One group defines PCS as an overall concept of personal telecommunications for all kinds of networks, the other group restricts PCS to mobile networks only. For the purpose of this study, the following broad definition of the CEC will be used.

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[3]   CEC Green paper on the liberalisation of telecommunications infrastructure and cable television networks. Part One Principles and Timetables 25.10.1994

[4]   ITU-T definition: Personal Mobility is the ability of a user to access telecommunications services at any terminal on the basis of a personal identifier, and the capability of the network to provide those services delineated in the user's service profile. Personal mobility involves the network capability to locate the terminal associated with the user for the purpose of addressing, routeing and charging (ITU-T Rec. F.851)

[5]   ITU-T definition: Terminal Mobility is the ability of the terminal to access telecommunications services from different locations while in motion, and the capability of the network to identify and locate that terminal. (ITU-T Rec. F.851); Terminal Mobility is restricted to a specific type of network.

> 1. PCS definition[6]: Personal Communications Services (PCS) is used as a generic term for services which provide person-to-person calling, independent of location, terminal used, the means of transmission (wired or wireless) and/or the choice of technology.

2.2 Universal Personal Telecommunication (UPT)

Another concept for personal telecommunications is the UPT service (Universal Personal Telecommunications), which is under development in ITU-T and ETSI (Annex E). UPT has been developed mainly by the fixed network industry with the goal of introducing mobility in the fixed network. This was done because the growth in mobile services has made it difficult for incumbent operators of fixed networks not to lose revenue to cellular network operators. Fixed network operators can respond to the threat from cellular operators by adopting advanced network technology, e.g. IN functionality. UPT is the means by which fixed network operators may introduce mobility facilities into their fixed networks in order to compete with mobile network operators. The use of UPT is not restricted to any specific network and all kinds of networks have to be able to support it.

> 2. UPT definition[7]: UPT is a service, which enables access to telecommunications services while allowing personal mobility. It enables each UPT user to participate in a user-defined set of subscribed services. They could initiate and receive calls on the basis of a personal, network transparent UPT-number across multiple network, on any terminal, fixed or mobile, irrespective of geographic location, limited only by terminal and network capabilities and restrictions imposed by the network operator.

2.3 Personal Numbering / Personal Numbers

The ultimate goal of the above concepts seems to be the same: personal telecommunications services covering all networks. With the growing convergence between fixed and mobile networks, no difference of objective can be seen between UPT and PCS. Both concepts require personal numbers. The goal of the introduction of personal numbers is to allow a high degree of personal mobility to the calling and the called party.

Mobility can also be achieved with number portability, which allows users to use their numbers in networks of other network operators. Number portability in fixed networks may be expanded to cover geographic portability but the complexity of the solution will grow in relation to the geographic area in which numbers can be ported. Portable fixed subscriber numbers are network addresses at the same time. The call is routed to or the routeing information is requested from the originating network in all cases. The originating network is always involved in call routeing. Portable fixed subscriber numbers are not considered as personal numbers in this study.

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[6]   CEC: Towards the Personal Communications Environment: Green paper on a common approach in the field of mobile and personal communications in the European Union COM(94) 145 final, Brussels, 27.04.1994

[7]   ITU-T Recommendation F.850

Number portability of mobile numbers between mobile operators is under consideration in Europe. The possibility of mobile subscribers to change their mobile network operator without changing their number and the possible use of mobile numbers as personal numbers may facilitate competition and offer new business opportunities in the telecommunications market.

The focus of this study has been changed from the consideration of only PCS to a broader approach, which is represented by the term personal numbering. One essential part of personal numbering is the personal numbers, which can be seen as a prerequisite for all types of personal telecommunications services.

> 3. This study will focus on Personal Numbers (PNs) which are a prerequisite for all types of personal telecommunications services.

3. Personal Numbering Environment

In order to understand the principle of personal numbering, the present numbering arrangements as well as the technical elements, which are needed to set up a personal numbering environment, are explained below (see also Annex D, Annex E and Annex F).

3.1 Numbering of Fixed Networks

All networks have their own individual numbering system. Each Network Termination Point (NTP) of a network has a specific number, which is used as an NTP address. Traditionally, in fixed networks the subscriber identification (in form of the subscriber number (SN)) has not been separated from the NTP number. The SN has been the network address of a subscriber, in accordance with ITU-T Recommendation E.164. Terminals themselves are not numbered in the fixed network.

Fixed network numbers are geographic or non-geographic in nature. Within a country, a geographic number denotes an NTP address containing an identification of the geographic area concerned and a non-geographic number denotes an NTP but the number does not contain any other geographic identity.

> 4. In fixed networks, subscriber identification is not separated from the NTP. The subscriber number identifies the network address of the subscriber.

3.2 Numbering of Mobile Networks

The operation of mobile networks is based on two separate addressing systems.

The first scheme utilises an E.164 number, which is used by the calling party to reach the mobile station. The caller identifies the mobile subscriber by his E.164 mobile telephone number only. This E.164 number is also known as the Mobile Subscriber ISDN number (MSISDN).

The second scheme uses E.212 identities[8] to identify the mobile station within the mobile network. This identity is named the International Mobile Station Identity (IMSI).

The E.164 number is public, while the IMSI is not known (and need not be known) by the public. An IMSI identifies each individual mobile station uniquely on an international level and allows the mobile station to roam among public land mobile networks, even in different countries. In order to identify the subscriber, all information regarding the subscriber is stored in the Home Location Register (HLR), which is one of the essential parts of mobile networks. In mobile networks, an NTP identified with the IMSI is only required for network internal purposes. The use of an IMSI is not restricted to mobile networks today. It may also be utilised by future services/standards, e.g. S-PCS, CTM, UMTS, FPLMTS and UPT.

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[8] ITU-T Recommendation E.212: Identification plan for land mobile stations

These two levels, the public known subscriber number and the network internal IMSI identity representing the NTP, give the mobile subscriber a high degree of mobility.

Another important part of mobile networks is the Subscriber Interface Module (SIM) card. The SIM card is placed in the mobile station and it includes the IMSI number and other information, which is relevant for authentication and security reasons. The SIM card is one of the main candidates for archiving true personal mobility. At present, the SIM card is restricted to a specific type of network and cannot be used in terminals of other networks. In the future, personal mobility by using a SIM card could be expanded to other networks if necessary terminal equipment is introduced.

> 5. Mobile networks utilise two different numbering systems:
> - the Mobile subscriber number, which is an E.164 number to identify the user and
> - the IMSI identity, which is an E.212 number to identify the terminal.

3.3 Numbering of IN-based Services

Numbers for IN-based services (e.g. freephone) are based on non-geographic E.164 numbers and could be seen as one kind of PNs. These numbers identify services, service providers and service subscribers rather than the network addresses or physical locations of the services being offered. The aim of these IN-based services is service provision itself rather than the person-to-person calling aspect. In IN-based services the service number is non-geographic in nature and is separated from the network address. This separation is based on the use of IN databases, which carry out the number translation from the non-geographic service number to the network address.

Example: Number of a freephone service: 0800-abcdef
             The service is provided by the number: 016-bcdefgh in fixed network
             or   050-cdefghi in mobile network

> 6. In IN-based services, subscribers are called by using a non-geographic E.164 number, which is separated from the Network Termination Point, where the service is being offered.
>
> 7. Numbers of IN-based services could be seen as one type of personal numbers.

3.4 Personal Numbers and Number Portability

Two types of PN might exist in parallel: those that are dependent on the service provider and those that are not. Both types of PNs provide users with geographic number portability.

PNs, which include a service provider identity, are used to route the call to a translation facility of a service provider. These numbers may not be portable to another service provider.

Without a service provider identifier, these numbers would be independent PNs because subscribers would be able - in addition to changing their location - to change service provider without changing their PN. The introduction of service provider independent PNs would mean the establishment of a database for personal numbers. The issue of the use of a database for this purpose requires further study in order to respond to a number of questions such as: What kind of infrastructure would be needed? How would calls be routed? Who would operate this database? How would the database be financed? What would be the rules for allocating numbers? What is the impact of number portability on the calling party? These questions need to be addressed when planning fully portable PNs.

The implementation of PN services can be done in steps: In the first step, to introduce provider identities in PNs with the advantage of starting the PN service quickly and with the drawback of no number portability between service providers. In the second step, a common database could be established including the service provider dependent data.

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8. Two types of personal numbers exist: those that are dependent on service providers, and those that are independent of service providers.

9. Personal numbers, which include service provider identities, are not necessarily portable between service providers.

10. Personal numbers could be introduced in two steps: First, to allow service provider identity without portability between service providers and second, to later establish a common database with all service provider dependent data in order to allow service provider portability.

3.5   Technical Elements of Personal Numbering

The call to a personal number needs some type of number translation facility in the network. Current implementation of PNs with service provider identity does not necessarily need IN facilities, but with the growth of personal services and service providers independence of PNs, IN capabilities will become more and more a prerequisite. The call to a PN will be routed to a translation facility, which provides either the routeing information of the home database or directly the physical address of the NTP. In order to translate the personal number into the network address, at which the called party is located, the following technical elements are needed (see Figure 1):

> 1) The **Personal Number** (PN),
> 2) A **translation facility** and
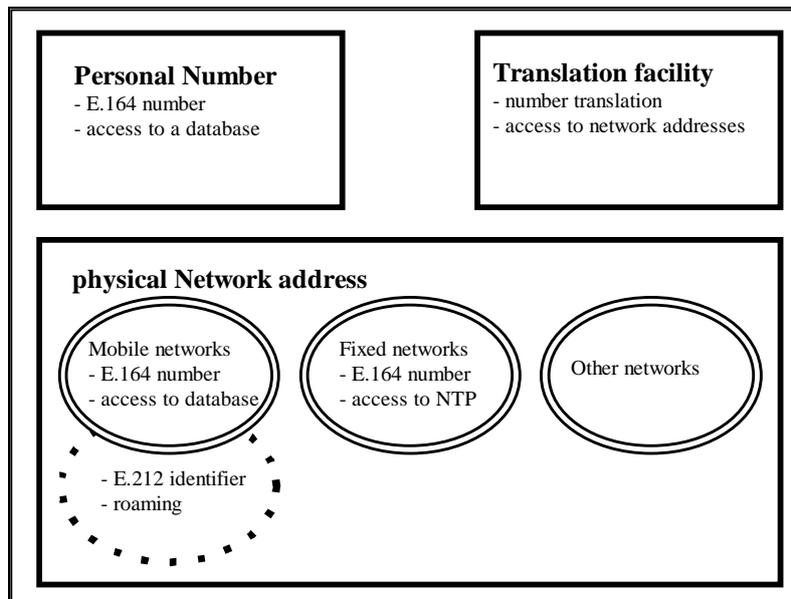> 3) The **physical network address**.

Figure 1   Technical elements of personal numbering

Personal Number

A personal number provides access to a database, which carries out the number translation and provides the network with the NTP address at which the called party is located. When using a PN, the caller does not need to know the NTP number (e.g. the location and the network of the called party). Even the holder of a personal number does not necessarily need to know the NTP address with which he is registered. This is already the case in mobile networks. The introduction of PN allows the development of different types of personal telecommunications services. Different types of personal numbers may exist in parallel, depending on the services offered.

Translation facility

As mentioned earlier, a number translation facility is a prerequisite for personal numbering. Number translation is usually made with the aid of a database. The use of an IN database for number translation is already familiar from national freephone and shared revenue services and from some initial applications of personal numbering. The basic technical network infrastructure is similar for all of these services but they may vary in their market placement.

Physical network address

Each network has its own number range, which is allocated from a national, regional or global numbering plan in accordance with E.164 Recommendation to identify NTP addresses. In mobile networks, mobile telephone numbers consist of E.164 numbers but NTP addresses identifying mobile terminals are E.212 numbers.

> 11. In personal numbering the following three elements are needed:
>   a) a personal number,
>   b) a number translation facility and
>   c) a physical network address where the called party is located.

4. Numbering Alternatives for Personal Numbers

At present the numbering of all new services, whether geographic or non-geographic, is based on the use of national numbering resources. The reason for this is simple - although there may have been demands for European or global numbering resources in the past, a number space was not previously made available to provide numbers for supranational services. In order to respond to possible future demands, number resources for personal numbers should be made available from national, European and global resources. However, the assignment of resources to such services should remain market driven.

Several operators are faced with the problem of integrating their different kinds of networks (Annex C). PNs might facilitate the integration process by using one number independent from networks.

4.1 Using National Resources for Personal Numbers

On the national level three different numbering alternatives for PNs were identified, which could be used alone or in parallel:

1) the use of geographic numbers as PNs,
2) the use of non-geographic numbers as PNs and
3) the use of non-geographic mobile numbers as PNs.

4.1.1 The Use of Geographic Numbers as Personal Numbers

The use of geographic subscriber numbers as PNs would benefit residential users because no number change would be required when changing the present fixed network number to a personal number. This would facilitate efficient network and service competition. The use of geographic subscriber numbers would only benefit the subscriber of that number. Other users will need new numbers if they would like to be identified by personal numbers.

Present fixed networks are based on the use of NTP addresses such as geographic subscriber numbers, which are non-IN-based. If these numbers are to be changed to personal numbers, an extensive introduction of IN capabilities into present networks is needed, which would consequently lead to extensive changes in the present network infrastructure. In addition to that, charging implications may arise for both the calling and the called party. Changing the present geographic numbers to PNs seems to be a difficult, costly and time-consuming task. The direct use of geographic numbers as personal numbers is not considered feasible in the short term.

> 12. The direct use of geographic numbers as personal numbers is not considered feasible in the short term.

4.1.2 The Use of Non-geographic Numbers as Personal Numbers

In national numbering schemes, National Destination Codes (NDCs) within the National (Significant) Number (N(S)N) denote different numbering areas within a country. These numbering areas may be geographic or non-geographic in nature. Non-geographic NDCs have no geographic identity within the country. Therefore, they should be considered for national PNs. The number range for national PNs should enable enough capacity to number all kinds of personal telecommunications services, including UPT, PCS, service provider dependent and service provider independent services.

Annex H gives an overview of the present or planned number ranges reserved for personal numbers, including UPT. Most of the number ranges used for PNs start with digit 7 or 8, where digit 7 has a lead. To allow an easy recognition of PNs in a national numbering scheme the number range starting with digit 7 should therefore be preferred[9], if a decision has not yet been taken.

When using a separate access code (i.e. a non-geographic NDC) for personal numbers, users have to change their current number in order to obtain personal numbers. From the network point of view, PNs are distinguished from other numbers and number translation can focus only on PNs. In order to obtain personal numbers, the number range for personal numbers has to be defined and a translation facility, including a service definition, has to be established. Although separate access codes may not be the most beneficial alternative from the user's point of view, they are technically the most suitable, easiest and quickest to implement. Several countries use this approach when setting up personal numbers.

Instead of using separate access codes out of the national numbering scheme for PNs, it is also possible to use existing IN-based numbers as PNs. This might lead to confusion for users, but IN-based numbers - like Freephone numbers - are even today used to access companies, and they can be seen as being "personal numbers". Therefore, personal numbers may develop from any IN-based service and dedicating a separate number range for PNs should not prevent these services from developing in their own number range. However, it must be noted that some countries have established rules and conditions regarding the use of designated number ranges. These number ranges can only be used for PNs, if the use does not contravene any rules and conditions related to that number range.

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13. The use of separate access codes for personal numbers on the national level is the most suitable solution for personal numbering.

14. Number resources for national personal numbers are reserved by using one or more separate NDC range(s) from the national numbering scheme.

15. Personal numbers may develop from any IN-based service.

16. NDC number range starting with digit 7 should be preferred for personal numbers if no decision has yet been taken.

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[9] On the global level, CC 878 has been reserved as an indicator for UPT. If 878 is also used as an UPT indicator on a national level, the global UPT number (after embedding the national UPT number) would consist of two times the 878 indicator (a total of 6 digits to indicate UPT). To minimise the length of dialled digits and to provide enough UPT number capacity, the national UPT indicator should be limited to two digits. Therefore, the necessity of having harmonised UPT indicator both on a national and global level is not considered significant.

4.1.3 The Use of Non-geographic Mobile Numbers as Personal Numbers

Mobile networks already have technical elements needed for utilising PNs and numbers used to call mobile subscribers are separated from network addresses. Present mobile network number translating facilities could offer possibilities to expand mobile numbering to personal numbering, where mobile numbers could be used as personal numbers. Although mobile numbers are strictly speaking different from PNs, the large amount of mobile numbers - combined with their inherent mobility, the existing technical framework and the fact that mobile subscribers can change their mobile network operator without changing their number - may provide the basis for new market opportunities.

From Annex H the conclusion can be drawn that no common access code for mobile networks has been established on a European level. Nevertheless, there are indications, which lead to the assumption that number range 6 could become such a common range.

The use of mobile numbers as PNs needs additional network development because it is not the basic task of mobile networks. In addition, this use might be in contradiction with existing national numbering rules. Nevertheless, mobile operators are ideally positioned to provide personal telecommunications services and the use of existing numbers as PNs might push the market. The conclusion of some studies[10,11] has been to remove the separation between mobile and personal numbering, because from a customer's point of view they are both services to provide personal telecommunications services and no major technical reasons exist to keep them separate.

If numbering of mobile networks is expanded to personal numbering, these new services should be described and their implications to networks and numbering need to be studied in more detail.

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17. Mobile network facilities could offer possibilities to expand mobile numbering to personal numbering.

18. The conclusion of some studies has been to remove the separation between mobile and personal numbering.

19. If mobile numbering is expanded to personal numbering, these new services should be described and their implications to networks and numbering need to be studied in more detail.

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[10]   OFTEL January 1997: The national numbering scheme

[11]   ETO report "Review of national numbering schemes on their openness to competition"

4.2 Using pan-European Resources for Personal Numbers

Although no clear demand for European PNs has been identified, it might not be wise to discard the possibility of such demand in the future. If a number space is not available, it may prohibit services from developing freely. ETNS should make personal numbers possible, when they are deemed necessary. Recently an ECTRA decision "to base the ETNS on Country Code 388" was approved. This decision was made in conjunction with alternative 2 of the proposed strategic options[12] to "implement an European numbering space for pan-European services but make no changes to country codes". Country Code 388 is temporarily reserved for the ETNS by the ITU-T. This decision will be reviewed by ITU-T in the first Study Group 2 meeting in 1999.

> 20. The European Telephony Numbering Space (ETNS) should offer numbering capacity which could be used for personal number services on a European level when deemed appropriate and when global resources are not available.

4.3 Using Global Resources for Personal Numbers

At present, only a few services are planned for introduction on a global level.

The International Freephone Service (IFS)
Country Code 800 was assigned by ITU-T as a global numbering resource for International Freephone Service (IFS). The service started in early 1997.

Global shared cost services and global shared revenue services
ITU-T is developing service descriptions of global shared revenue and global shared cost services. Up to now, there have been no requests for global numbering resources, but a request to study the numbering of such services can be clearly foreseen.

The Universal Personal Telecommunications service (UPT)
The present solution for global personal telecommunications services is UPT as defined by ITU-T. ITU-T has recently reserved Country Code 878 as a global identifier for the UPT service. Other personal telecommunication services than UPT cannot be numbered from this number range because this number range is applicable only for the UPT service. The UPT service can start by using national numbers and may later evolve to global numbering. ITU-T Recommendation E.168 describes possible evolution paths from national UPT numbers to global UPT numbers. The different scenarios for UPT envisage different mobility coverage connected to different dialling schemes, e.g. smaller coverage with shortest dialling sequence.

Other global services
Except for the services mentioned above, no discussion to establish other global services is underway in ITU-T so far. Personal telecommunications services, which differ from UPT, may not utilise UPT numbers. At a global level, no other number range exists so far for personal telecommunications services.

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[12] Consultation on Strategic options for numbering of telecommunication services in Europe 27 July, 1994

21. Only a few ITU-T recognised global services are defined or under development.

22. The allocation of Country Codes to global services is restricted to ITU-T recognised global services only.

23. UPT is the only ITU-T recognised global service for Personal Telecommunications. Other personal telecommunications services, which differ from UPT, may not be able to utilise the UPT number range.

24. An evolution from national to global resource for UPT is defined in ITU-T Rec. E.168.

5. Demands for Personal Numbers

At present the major part of numbers in European countries are geographic-oriented and only a minority is non-geographic-oriented. Several service developments and studies indicate that this ratio may change significantly in the future.

Geographic-oriented numbers
It can be estimated that the total amount of geographic-oriented numbers will be grow at a slow pace, although demand for DDI, for different ringing tone services and for ISDN may lead to significant growth in numbers.

Non-geographic-oriented numbers
Three main areas can be distinguished of non-geographic oriented numbers: the mobile numbers, the personal numbers and numbers for IN-based services.

> **Mobile numbers**
> Taking into account the development of the mobile sector and assuming that the present growth will also be valid in the future, the demand for non-geographic numbers for mobile services may increase dramatically.

> **Personal numbers**
> It is a common demand of users to have one number "forever", a number which is not subject to number changes[13], a number which can be used in different locations across different types of networks. When the present method of estimating number capacity, i.e. "one number per household" is changed into "one number per person", the total amount of non-geographic numbers needed for personal numbers will rapidly increase. It might be estimated that one half of European citizens will really need their own personal number. The population in European countries is approximately 560 million people and this leads to a demand of around 300 million personal numbers. These additional 300 million non-geographic numbers can be taken either from national, European or even global numbering resources. This assumption is in line with the study made by Coopers & Lybrand for OFTEL[14] where a personal number penetration of 25-50 % in the UK by 2010 is estimated.

> **Numbers for IN-based services**
> The number demand for IN-based services, for example freephone, is very unclear. Nevertheless, it can be assumed that demand for these numbers is smaller than the demand for fixed, mobile and personal numbers. Therefore, numbers of IN-based services are not included in the table below.

Table 1 summarised the subscribers growth in Europe under the assumptions made before. All figures in the table are only very rough estimates and may be subject to debate.

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[13] A personal number is not a guarantee for not being bothered with future number changes and long term stability might depend on the numbering scheme, network intelligence and bi-/multilateral agreements between involved network operators

[14] Coopers & Lybrand: UK Telecommunications Numbering Strategy Study, Report on the future demand for capacity in the UK numbering scheme, March 1996

	number resources geographic / non-geographic	today	around 2000	in the long term
fixed network subscribers	mainly geographic	180	200	300
mobile networks subscribers	mainly non-geographic	20	100	300
personal numbers	non-geographic	0	20	300

Table 1 ETO's rough estimation of subscribers growth in Europe (in millions)

On a national level, the demand of personal numbers is market driven. Different types of personal numbers are needed. Depending on subscriber needs these personal numbers may be operator specific, operator independent, national or even European/global. An extensive growth is expected in national personal numbers. The process of reserving or allocating personal number ranges on a national level has already been started, as shown in Annex H.

On a European and global level no clear evidence has been found identifying demand for PNs so far. Mobility functions - which are one of the aims of personal telecommunications services - in mobile networks are mainly covered by global roaming features. For example, a mobile subscriber can use his national mobile number also when travelling in other countries. This is an advantage when on short travel. In the case where a subscriber is permanently moving from one to another country and wants to keep his mobile number, calls to the mobile number would always be routed to its "previous home country" and then re-routed to the mobile user in his new home country. This would make mobile communication very expensive. To avoid these expenses the only alternative is to change the mobile number. This example is not only restricted to mobile numbers. The use of national personal numbers will lead to the same problems as with mobile numbers. European or global personal numbers may solve this problem, because the numbering area of such non-geographic numbers is much larger compared with the numbering area of national non-geographic numbers. However, this would benefit only people who are often changing their permanent location from one European country to another one. The demand on the European level for such kinds of services and numbers seems to be marginal.

Numbering demand for European personal numbers may - however - grow, taking into account the rapid development of networks and services in the future. It may be assumed that service competition and new, yet unforeseeable customer demands may lead to additional demand of personal numbers on a European and global level. It would be unwise to discard this possibility in the future. European and global numbering resources should facilitate personal numbers when they are deemed appropriate.

25. The demand for personal numbers on a national level is market driven. No strong demands for personal numbers across national borders have been identified. This does not mean, however, that we can discard the possibility of such a demand in the future.

26. The introduction of personal numbering implies additional demands for non-geographic numbering resources at the national level and may imply additional demands on the European or global level in the future.

6. Implementation Aspects of Personal Numbers

This chapter summarises implementation aspects of PNs regarding time scales and evolution. Depending on future European decisions, there is a need to study these aspects in detail.

6.1 Time scales

The implementation of personal numbering is dependent on the availability of numbering resources. Three different numbering resources have been identified: national, European and global. Only national, not-harmonised resources are immediately available and the decision to reserve numbering resources for national personal numbers is a national one.

ECTRA has adopted a decision on the future ETNS which is based on the use of a global numbering resource and ITU-T has reserved CC 388 for the ETNS trial. The usage of an ETNS depends not only on the availability of numbers but also on the availability of advanced routeing and signalling systems and multilateral agreements on charging and on accounting. According to ETSI studies, a minimum of 18 months is required, after a decision on the reservation of an ETNS country code has been made, to allow preliminary network implementation[15] and to develop/adapt operator internal procedures.

On the global level, only UPT is considered a personal telecommunications service and country code 878 was recently reserved for UPT. The use of this country code depends on the introduction of IN infrastructure and commercial agreements between operators and UPT service providers.

The following table summarises the availability of numbering resources on national, European and global levels.

Resource		Status, depending on	Available for allocation
National	National / not harmonised through Europe	National decision	now
ETNS	using global resources	ITU-T decision	18 months after reservation, in 1999 at the earliest
Global	Global/UPT	development of IN infrastructure and commercial agreements	unclear, in 1998 at the earliest

Table 2   Availability of Numbering Resources for Personal Numbering

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[15]   ETSI ETR NA0214 European Telephony Numbering Space - Analysis of preferred options

6.2   Evolution

Number evolution may benefit users wanting to expand the operating area of their personal number from a national level to a European or global level, but these evolution paths may not always be needed. Two different evolution approaches are identified. The first one is to add some extra digits in front of the existing international personal number. An example for this kind of evolution is UPT. The second approach is not to use the whole international number for evolution purposes but only a part of it. In this case, e.g. only the subscriber number of the national number is embedded in the global number. This approach was used during the service start of UIFS. The choice of the evolution approach has an impact on the usable number length before such an evolution takes place. The flexibility regarding number length is much higher with the embedding approach than with the retaining approach. Evolution aspects should be taken into account in an early stage of planning the number structure and the use of numbering resources. Some additional evolution considerations of existing national numbers can be found in Annex I.

27. Evolution aspects, from the national level to European and global levels, have to be taken into account at an early stage of planning the number structure and the use of numbering resources.

7.   Proposals for Personal Numbering in Europe

This chapter summarises issues, which have to be taken into account when planning the numbering of personal telecommunications services, and makes proposals for numbering these services.

Based on the facts that:

- The focus of the study is personal numbers, which are used for person-to-person calling.

- Personal numbers are a prerequisite for all types of personal telecommunications services.

- Different types of personal numbers may exist in parallel, e.g. service provider dependent PNs, service provider independent PNs, national PNs, European PNs or global PNs.

- The introduction of personal numbers implies additional demand for non-geographic numbers on all levels.

- The direct use of present non-IN-based fixed network numbers as personal numbers is not considered feasible in the short term.

- Mobile networks could offer possibilities to expand mobile numbering to personal numbering.

- The separation between mobile numbers and personal numbers may be removed in the long run.

- The allocation of Country Codes to global services is restricted to ITU-T recognised global services only.

- A demand for personal numbers on the national level exists, but a demand for European personal numbers has not been clearly identified.

- The NDC number range starting with the digit 7 is mainly reserved or in use for personal numbers.

ETO concludes that:

- The use of one or more separate access codes for personal numbers on the national level is the most suitable and quick solution for personal numbering.

- Personal numbers could be introduced in two steps. Firstly, to permit personal numbers with a service provider identity to allow easy routeing, without portability between service providers. Secondly, to establish a common database including all service provider dependent data, in order to facilitate service provider portability.

ETO makes the following proposals:

> 28. Number resources for national PNs should be reserved by using one or more separate NDC ranges from the national numbering scheme. In order to allow for an easy recognition of personal numbers by users, the use of NDCs starting with the digit seven should be preferred.
>
> 29. The number range reserved for PNs should be used for all types of personal telecommunications services in which the focus is person-to-person communications. This also includes mobile services.
>
> 30. Personal numbering may develop from any IN-based services. Dedicating a separate number range for PNs should not prevent these services from developing in their own number ranges.
>
> 31. The ETNS should provide resources for European PNs when needed. In order to allow easy recognition of European personal numbers in the future, ETNS number range 7 - as particularly appropriate for European PNs - should not be allocated to other services.

ANNEXES

Annex A   Work Requirement

1. Subject: **Numbering related to the implementation of UPT in Europe including the creation of an ETNS and the problems of PCN numbering and portability.**

The title was changed in accordance with an agreement made between ETO and the European Commission to "**Numbering related to Personal Communications Services (PCS) in Europe**".

2. Purpose

The work order covers the work that the European Telecommunications Office (ETO) will conduct on behalf of the European Commission in the important area of numbering of telecommunication services. This Annex focuses on the implementation of Universal Personal Telecommunications (UPT) in Europe, including creation of a European Telephony Numbering Space and the problems of Personal Communications Network (PCN) numbering and portability.

3. Justification

The issue of numbering at the European level was addressed in the "Council Resolution on the promotion of Europe-wide co-operation on numbering of telecommunications services" (92/C 318/02; 19 November 1992).

The Council of Ministers adopted on 22 July 1993 a Council Resolution on the review of the situation in the Telecommunications sector. The Council Resolution sets the future agenda for the further liberalisation of public voice telephony.

The design on numbering schemes should aim to provide stability in order to avoid undue changes and costs, while at the same time be flexible enough to adapt to future developments and facilitate emerging services in the telecommunications sector.

It is difficult to project what services concepts will be developed and offered in the long term. Today, such concepts are Universal Personal Telecommunications (UPT) and Personal Communications Network (PCN). The interception of current developments of the National Numbering Schemes with an aim to harmonise the future numbering of UPT/PCN and, for Europe, of the new ITU-T Recommendations on the numbering of UPT/PCN are important objectives.

4. Work requirement

(1) to analyse the present visions on future development of telecommunications networks and services and their effects on numbering and addressing.

(2) to examine Global / European Issues on UPT/PCN-numbering and related demands for European numbering. Regarding UPT/PCN implementation within Europe: to find issues to be taken into account when developing the European numbering.

(3) to focus the findings to the proposed strategic options and to make proposals for numbering of UPT/PCN in Europe.

5. Execution

The work on these issues shall be carried out in close co-operation with the CEC, the ECTRA PT on Numbering and the European Numbering Forum (ENF). The final report shall be delivered to the CEC not later than 1 December 1996.

6. Deliverables

Two interim reports and one final report shall be delivered.

The first interim report shall be delivered during the course of the work, containing 1) the present visions on future development of telecommunications networks and services, their effects on numbering and addressing and different aspects related to UPT/PCN-numbering both on global and European level and 2) the findings of the issues to be taken into account when developing the European numbering. The first interim report will be delivered approximately 1 May 1995.

The second interim report shall focus the findings to the proposed strategic options and to make proposals for numbering of UPT/PCN in Europe. The second interim report was delivered approximately September 1996. The report shall be submitted to CEPT/ECTRA for information and comments.

The final report shall contain the findings and proposals, as approved by CEPT/ECTRA and will include any comments individual CEPT/ECTRA members have on these issues in their respective national regimes. The final report shall be delivered to the CEC not later than December 1996.

All reports shall be made available in draft form one month before a liaison meeting between the CEC and the ETO discusses the results and approval can be given for their release.

The Commission shall receive three copies of the interim reports, while the approved final report shall be made available in 15 bound copies, one unbound copy and one copy on floppy disk in Word for Windows V2.0 format. Graphics shall be made available on separate hard copies.

7. Manpower

It is expected that this work can be accomplished in 9 man-months of effort at expert level, including subcontracting.

8. Subcontracting

Subcontracts may be given to external experts for the execution of parts of this contract, representing 1 man-month.

Annex B   Views and opinions on PCS

PCS view including only wireless technology

Federal Communications Commission
"... a family of mobile or portable radio communications services which could provide services to individuals and business and integrated with a variety of competing networks... the primary focus will be to meet communications requirement of people on the move..."

One US Perspective:
"PCS is a range of individualised telecommunications services that enable people or devices to communicate independent of location."

Pacific TeleLink:
"... a high quality, low cost, mass market wireless service which allows you to communicate at places that suit your needs using a low cost, compact lightweight handset."

PCS view including different kind of networks

The European Commission[16]
"Personal communications... envisages the future offering of a range of telecommunications services that are able to be flexible tailored and packaged to meet the needs of individuals, allowing them to communicate independently of their location or access method. A common element of this view is that wide appeal and low prices will allow mass markets for such services to be realised. Personal Communication will ultimately allow person-to-person calling independent of location and the terminal used, the means of transmission (wired or wireless) and/or the choice of technology."

The European Commission[17]
".... PCS are likely to be based initially on combinations of existing systems such as GSM, DCS1800 and DECT, together with intelligent network functions in the fixed network providing for mobility via fixed network .... Requirements to support very high traffic densities in areas such as office centres .... which DECT is best placed to accommodate, may give rise to technological motives for dual mode terminals..."

Eutelis Consult (Scenario Mobile Communications 2010)
"... means an individual communication which is no longer related to the equipment but to the user. A specific number is attached to the person and not to the terminal. The subscriber will be within reach at any time and place..."

Another European Perspective:
"PCS is used to describe a service which will evolve from the merging of several currently disparate services. Both fixed and wireless networks have a role to play in PCS. The key elements of PCS are
- Personal numbering - a number which is allocated to a person, not to a phone
- "IN type" capability which provides mobility management....."

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[16]   CEC: Towards the Personal Communications Environment: Green paper on a common approach in the field of mobile and personal communications in the European Union COM(94) 145 final, Brussels, 27.04.1994

[17]   CEC: Towards the Personal Communications Environment: Green paper on a common approach in the field of mobile and personal communications in the European Union COM(94) 145 final, Brussels, 27.04.1994

M.o.U. Personal Mobile Telecommunications - European Initiative:

"... the personal use of telecommunications services by mobile users who can select the terminal equipment or location independently of existing links or can move with the terminal during the call. Users must be able to access their telecommunications service from any location, independently of network access and the terminal used, in a public or private environment...."

A service provider Perspective:

"PCS is a low-cost response to the requirement to provide, maintain and control telecommunications between people wherever they are and whatever they are doing, and between their terminal devices, according to individual needs, to satisfy the mass market."

Annex C   Visions of Future Networks - The Evolution of Networks

It is a difficult task to forecast how networks will evolve in the future. Different organisations and operators have prepared studies on this issue. Their views are summarised as follows:

European Visions

ETSI: In ETSI[18] a standard for cordless terminals is being developed. This project - called Cordless Terminal Mobility (CTM) - supports terminal mobility and can be seen as a supplement to GSM. The goal of CTM is to supply terminal mobility in a restricted area, for example in the office or at home. The use of CTM terminals is not restricted to private networks - public networks could also be included. As a solution for local mobility, CTM would be less expensive than GSM, since the infrastructure is concentrated in specific areas and does not cover the entire country. Although CTM is designed for local mobility, roaming to other connected CTM networks - even those found abroad - is possible. The demand for an alternative network access, e.g. GSM, seems necessary for those users who also want to be reachable outside the CTM coverage area. A dual handset with CTM and GSM (or CTM and DCS1800) functionality can solve this problem. Nevertheless, in this case a user needs both a CTM and GSM subscription. It could be useful for the user to have only one subscription and one number through which he is reachable in both networks, depending on where he is registered. To allow this function, the CTM network and the GSM network have to exchange information about the user or both networks have to share the same database. The integration of different types of networks is a long-term goal.

RACE project MONET: The Race project MONET[19] has investigated the fixed network requirements as regards to UMTS. The project focused on the design of an open and flexible fixed infrastructure for UMTS. The main goal of the project was to design the UMTS network as an integrated part of advanced networks for fixed telecommunications services. UMTS was envisaged as the mobile extension of such networks, offering in principle the same range of services as those available to fixed network users. One result of the project is that UMTS is now regarded as the mobile access part of the B-ISDN and an integral part of the future broadband infrastructure. The prospective requirements of fixed and mobile networks are very similar. For this reason, plans to merge existing fixed and mobile networks have to be developed.

Deutsche Telekom AG: Deutsche Telekom[20] is also considering the evolution of networks. The idea is to use all telecommunication networks as a means of offering services, without setting up special infrastructures for these services. This idea is also based on economics, because dedicated networks are more expensive than integrated ones and in a competitive area cost aspects have a high value. The goal is to avoid high fixed starting costs when introducing new services. A basis for such a network will be the use of IN, a standardised signalling system, preferable Signalling System #7 and the use of databases, which are spread over the network.

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[18]   Graham Crisp: IIR conference September 1995

[19]   Race Telecommunications Summit 22.-24. November 1995

[20]   Karl Thomas: Die zukünftige Netzevolution bei der Deutschen Telekom, NTZ 3/1995

Ericsson: Ericsson[21], a mobile equipment supplier, estimates that the number of PCS/PCN subscribers in the world will be between 150 to 250 million by the year 2000. By that time, more than 50 % of all new public subscriptions will be wireless connections. In addition to cellular services, other mobile services such as wide-area paging and mobile data will increase at high growth rates. By the year 2000, the present 36 million wide-area paging subscribers in the world are expected to grow to some 100-120 million. Mobile data will grow from some hundred thousand users to between 10 and 15 million in the year 2000. There is also tremendous growth in the number of cordless phones being used in the home area. Today, the majority of all new residential phones purchased in the US are cordless - providing home zone mobility. This means that more than one third of the US households own cordless phones. In the business sector, the usage of wireless PBXs can result in a growth in productivity when, for example, customers can always reach account managers. This function requires an intelligent PBX, which can screen incoming calls and route the calls to unoccupied wired or wireless phones or to answering machines.

U.S. Visions

Bellcore: The approach of Bellcore[22] is to look at the different networks, which exist today. There is one network for POTS (Plain Old Telephone Service), another for X.25 (Data Communication), a third one for Frame Relay (Data Communication), one for ISDN (Integrated Service Digital Network) and one for SMDS (Switched Multimegabit Data Service) etc. All networks are separated from each other and the necessary interworking makes it difficult for all these networks to operate together. With the capability of ATM, which is the essential part of B-ISDN, it is possible to use ATM (Asynchronous Transfer Mode) as a basis for all PSDN and ISDN services. The time frame for implementing this integrated network based on ATM will be more than one decade. ATM addressing also supports E.164 numbers, and the use of existing numbering schemes is therefore possible.

AT&T: The studies of AT&T[23] focus more on the increasing demand for mobility in all networks and the different services which are offered in fixed and mobile networks today. In mobile networks, a user is automatically located after registering himself. In fixed network, this function is not yet available, but with UPT service and IN capability the network is also able to track the user. Both methods are similar in their result (i.e. tracking of the user), but differ from one another in the technical solution used. In mobile networks - for example GSM - a HLR (Home Location Register) is used and if the user visits another network a VLR (Visitor Location Register) is used. UPT, however, uses the IN platform. AT&T believes "that cellular networks are destined to become fully integrated into a common communications infrastructure - comprised of both wired and wireless networks, with an extensive IN component. Present networks, such as ISDN, public data networks, business cordless networks, private mobile radio, paging and cellular networks etc. will all gradually converge towards a single broadband integrated communications infrastructure possibly based on B-ISDN. Only such infrastructure will be able to present a seamless, fully transparent interface to the user."

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[21] Trends in Mobile Communications; Towards a New Era in Mobile Communication
[22] Presentation of Bellcore during a ITU-T SG2 meeting in 1994
[23] The 1995 GSM World Congress

Summary of the visions of future networks

The following bullet items summarise the essential features of future telecommunications networks. Additional documentation, which is listed in Annex J, has also been taken into consideration.

The main features of future telecommunications networks will be:

- the digital switching technique, with a wide range of possible features, which is today used to offer services like Euro-ISDN and its supplementary services;
- IN technology, which will be used to define different user-specific profiles for different services like Freephone or Shared Cost Services;
- the signalling system, like Signalling System #7, which is used for interworking between networks (fixed and mobile network) and which can be used to manage the different demands arising from new services;
- the separation of network architecture and services. The network will be a platform for handling services and must meet the changing demands of these services. Network architecture is not directly linked to the evolution of services, because the rules for developing a network extend far beyond the rules for developing services;
- the introduction of integrated network databases, which will be used for different services as well as for allowing users to build their own individual service profiles. In such databases, subscriber data can be used for different purposes;
- greater integration of existing fixed and mobile networks, including data networks towards the creation of an integrated telecommunication network.

Annex D   Numbering of Fixed and Mobile Networks

This Annex provides some figures and statements concerning fixed and mobile networks and their development and numbering.

National Numbering Schemes are mainly used to number wireless and fixed networks. Numbering is always based on ITU-T Recommendation E.164. Special numbering recommendations were developed (E.168, E.169, E.191) for a small number of global or special services. For historical reasons, all National Numbering Schemes are fixed network oriented. Only rudimentary IN capability is available, but most of the networks are strengthened with IN technology. It seems that IN technology will become the basis for advanced future services like PCS, but that development towards IN is slow. IN capability in this context means the ability of the network to administer subscriber information regarding its present location in the network.

Fixed network (ISDN)

Most of the European fixed telephone networks are based on analogue non-Stored Program Controlled (SPC) technology, analogue SPC technology and digital SPC technology. The development of current networks and services towards ISDN networks is based on the use of digital SPC technology. The degree of digitalisation of networks varies between countries. At the end of 1994 in Western Europe the degree of digitalisation of local exchanges was approximately 65% and of lines with direct international dialling 100 %. In Central and Eastern Europe, the degree of digitalisation was 17.4 % for local exchanges and 75.8 % for lines with direct international dialling. In the former Soviet Union the digitalisation degree was 11.3 %[24]. In Western Europe ISDN penetration in 1995 was less than 1%. However, all new exchanges to be purchased today are based on digital technology. The degree of digitalisation of telephone networks will rapidly increase when old technology is replaced by technology that is more modern. In parallel with the exchange of old equipment, ISDN capability is growing at an annual rate of approximately 40%.

Area	Digitalisation degree in local exchanges	ISDN penetration in 1995	Direct international dialling
Western Europe	65.2	< 1 %	100 %
Central and Eastern Europe	17.4		75.8 %
Former Soviet Union	11.3		?

Table 3 The degree of digitalisation in Europe

IN technology is based on the use of digital SPC technology and modern signalling systems. Today IN exchanges are separate entities in the network and IN technology is mainly being used to facilitate some services (e.g. Freephone, Shared Revenue service). The telephone network itself is not yet based on IN technology. However, all new telephone exchanges to be purchased are equipped with IN-facilities and the IN-capability of the telephone network will be increased in the future. It seems that present fixed networks will slowly change towards IN-networks.

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[24]   Communications Week International: Alcatel statistics 95

Digital network technology and modern signalling systems are a prerequisite for introducing advanced services. In order to enable services to develop rapidly, the digitalisation of networks and implementation of advanced network technology should be strongly supported.

The numbering of fixed networks is based on National Numbering Schemes, in conformance with ITU-T Recommendation E.164. E.164 gives countries the opportunity to use the number space behind the Country Code for national purposes without any guidelines. Several years ago, the fixed network was the only network, which had to be numbered. Therefore, National Numbering Schemes were mainly based on the demands of fixed networks.

Public Switched Data Networks (PSDN)

Public Switched Data Networks are based on digital technology and are numbered in accordance with ITU-T Recommendation X.121.

Broad-band-ISDN (B-ISDN)

Broadband ISDN (B-ISDN) numbering and addressing is described in detail in ITU-T Recommendation E.191[25], which is based on E.164. E.191 provides guidance and requirements for addressing reference points located at subscriber's premises, servers, and for allowing communications between terminals, applications and persons in B-ISDN networks.

Global System for Mobile (GSM)

GSM is a central standard, developed by ETSI, for cellular, digital (second-generation) mobile systems. It is now in operation or planning to operate in more than 60 countries all over the world. GSM is supported by Directive 87/372/EEC and by a Council Recommendation and Resolution on its co-ordinated introduction. The system supports terminal mobility, roaming and a broad range of services[26] and GSM is the basis for further developments, e.g. UMTS. GSM networks are numbered from the national numbering resource.

Today, more than 100 mobile operators in more than 60 countries have introduced or are planning to introduce national GSM networks. In areas with a high population density and therefore with a higher rate of use, the GSM network could exceed its operational limits in dealing with a huge amount of traffic ($\approx$10 Erlang/MHz/km^2)[27]. The introduction of DCS1800, which does not differ from GSM except in the frequency range used (1800 MHz instead of 900 MHz as in GSM), has overcome this limitation ($\approx$ 20 Erlang/MHz/km^2).

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[25] Draft Recommendation E.191: B-ISDN numbering and addressing, Com 2-R 35-E; June 1995

[26] CEC: Green paper on a common approach in the field of mobile and personal communications in the European Union 27.04.1994

[27] The unit Erlang/MHz/km^2 includes different parameters which impact on the system capacity in terms of number of the subscribers who can be served

Digital Communication System at 1800 MHz (DCS1800)

DCS1800 is a standard for micro cellular communications systems, which was developed by ETSI and is based on advanced GSM technology. The DCS1800 network has evolved from the existing GSM standard and, therefore, DCS1800 is referred to as GSM at 1.8 GHz. In some publications, the term PCN is used as a synonym for DCS1800. PCN/DCS1800 as well as GSM supports terminal mobility[28], but according to the definition made in Annex G does not support personal mobility. DCS1800 can be seen as an advanced GSM network operating within a higher frequency range. PCN networks are numbered from national numbering resources. The U.S. counterpart is called DCS1900, operating at 1900 MHz, because it was not possible to use the 1800 MHz band.

To fulfil the number demands of all mobile operators, blocks of numbers are allocated to them by the national authority. Out of these blocks of numbers, individual numbers will be assigned to customers by the mobile operator. Cellular numbers are national numbers and their area of coverage is usually nation-wide. Mobile numbers are geographic portable within one country only. They are not portable between service providers and are not geographic portable between countries.

From the user's point of view, non-portable mobile numbers lead to two kinds of problems: Firstly, the lack of portability between service providers prevents the user from changing mobile operator. Secondly, when a mobile subscriber of one country wants to move permanently to another country, he has to change his number in order to avoid high telephone bills caused by the routeing of calls to the original country. Mobile numbers should be portable at a global or at least a European level.

The same facts, which apply to digital mobile networks, also apply to existing national analogue mobile networks. From the numbering point of view, the technology used has no impact on the numbering of such mobile services.

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[28]   CEC: Green paper on a common approach in the field of mobile and personal communications in the European Union 27.04.1994

Annex E   Existing and Future Mobility Services / Networks / Technologies / Standards

Digital European Cordless Telecommunications (DECT)

One of the first approaches to terminal mobility was the use of CT2 terminals, which allowed subscribers to make calls, but not to receive them. This was not successful because of the high subscriber costs, the incompatibility of different systems and the restricted nature of the service. At that time, the cellular market in Europe was fragmented. An analogue terminal of country A could not be used in country B and vice versa. The introduction of DECT could solve this problem. The digital cordless standard DECT is being developed by ETSI and is supported by a Council Decision by the European Union. DECT will be used to offer mobility in offices via cordless PABX, at home and in public areas via "telepoint services" and in the local loop to provide connection to the fixed network. A combination of DECT and GSM/DCS1800 features in one handset[29], a so-called "dual mode terminal", is planned, and for this reason an efficient procedure for dealing with numbering problems arising from such a combination must be developed.

Several applications of DECT (up to 500 Erlang/MHz/km^2) were identified[30]:
- **Business**: Undoubtedly an initial application for DECT cordless technology will be in offices. By installing a cordless PBX, companies can equip key staff with cordless handsets, enabling them to move freely around the company's premises while making and receiving calls.
- **Small offices and home offices**: Cordless is not just for large companies; its benefits extend to the "Small Office/Home Office" (SOHO) world. The ability of small DECT systems to transfer calls and enable internal communications are the key features of such an application.
- **Residential cordless**: The high level of cordless phone sales confirms that residential customers value mobility, despite the early problems of poor speech quality, lack of security, and high levels of interference. DECT cordless domestic phones bring professional features and facilities to private users; they also eliminate the problems associated with early, analogue cordless phones.
- **Public access:** Wireless, using both fixed and portable terminals, is rapidly establishing itself as an economic alternative to copper wire in the local loop, thereby letting operators roll out modern networks very quickly. The same basic technology is also being applied in industrialised countries to facilitate competition and enable innovative new communication services.

Universal Personal Telecommunications (UPT)

This Annex provides a summary on UPT numbering. Work on the standardisation of UPT is currently being carried out by ITU and ETSI. Basic ITU-T numbering Recommendations are listed in Annex J.

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[29]   CEC: Green paper on a common approach in the field of mobile and personal communications in the European Union 27.04.1994: "... PCS are likely to be based initially on combinations of existing systems such as GSM, DCS1800 and DECT, together with intelligent network functions in the fixed network providing for mobility via the fixed network... Requirements to support very high traffic densities in areas such as office centres... which DECT is best placed to accommodate, may give rise to technological motives for dual mode terminals..."

[30]   Philips Communication Systems: Your Personal Guide to DECT

Universal Personal Telecommunication (UPT) is a concept developed by ITU-T. Within Europe, ETSI has conducted extremely valuable work on UPT. Universal Personal Telecommunication (UPT) enables users to access telecommunications services while allowing Personal Mobility. It enables each UPT user to participate in a user-defined set of subscribed services and to initiate and receive calls on the basis of a personal, network-transparent UPT number across multiple networks at any terminal, fixed or mobile, irrespective of geographic location, limited only by terminal and network capabilities and restrictions imposed by the network operator[31].

UPT removes the fixed association of terminal with user identification. In order to offer users the capability of establishing and receiving calls on any terminal and at any location, the identification of UPT users has to be treated separately from the addressing of Network Termination Points. This is done by the means of a UPT number, also called Personal Number. UPT users are personally associated with their own UPT numbers, which are used when making and receiving calls.

UPT has been developed to allow users to "roam" in fixed networks and this approach was expanded for use in all existing and future networks.

ITU-T has recently reserved Country Code 878 for global numbering of UPT, in accordance with the numbering scenarios defined in ITU-T Recommendation E.168. These scenarios are based on the international numbering plan described in ITU-T Recommendation E.164. The UPT service gives subscribers (and authorised users) the ability to make and receive calls from any terminal (fixed or mobile) connected to the public telecommunications network, by accessing a network base or network-attached database, which contains a subscriber service profile.

The UPT Service has been divided into three Service Sets. Only UPT Service Set 1 (a restricted short-term UPT service scenario providing the UPT service over ISDN and PLMN networks and only supporting telephone service) is outlined in detail in Draft ITU-T Recommendation F.851. In UPT Service Set 2 (Basic UPT service scenario), various data services may be provided, for example, but the services in UPT Service Set 3 (Enhanced UPT service scenario in long term) are not known today. When developing a numbering scheme for UPT, long term issues have to be given much consideration.

The following definition of UPT was taken from UPT Service description ITU-T Recommendation F.851[32]:

> "UPT enables access to telecommunication services while allowing personal mobility. It enables each UPT user to participate in a user-defined set of subscribed services and to initiate and receive calls on the basis of a personal, network-transparent UPT Number across multiple networks on any, fixed or mobile terminal, irrespective of geographic location, limited only by terminal and network capabilities and restrictions imposed by the network operator."

ITU-T Recommendation F.850 also lists six main principles of UPT. These are:

a) Personal Mobility, whereby the UPT user may move between terminals to make and receive calls on a global basis, based on the UPT User's Service Profile;
b) UPT user identification based on a network transparent UPT Number;
c) Charging and billing on the basis of UPT user identity rather than terminal or line identity;

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[31]   ITU-T Recommendation F.850: Principles of Universal Personal Telecommunication (UPT).
[32]   ITU-T Rec. F.851 Universal Personal Telecommunication (UPT) - Service Description (Service Set 1)

d) Standard access and authentication procedure for UPT facilities on a global basis across multiple networks;

e) Control and flexibility for the UPT User and Subscriber in the selection of the UPT user's telecommunication services in a personalised UPT service profile;

f) Security and privacy, including UPT User authentication and protection for third parties.

From the numbering point of view, principle b) is the most important once. What would a UPT number look like in a European/global context, taking into account the fact that the models have already been standardised or are under study? Different numbering scenarios related to UPT on a global context are described in UPT numbering Recommendation E.168[33].

What might be the numbering demand for UPT? One answer could be found in the UPT Service description in section 2.2.6 "UPT numbering is based on a personal UPT number which uniquely identifies the UPT user". More specifically related to numbering and dialling aspects is section 4.2.1. Below are the numbering demands of UPT from the service point of view quoted from the UPT service description.

a) The UPT number structure should be such that the UPT number is easily recognised and distinguished from ordinary (non-UPT) numbers by users and potential calling parties. This enables calling parties to know or infer that the call might be charged in a special manner, handled in a different manner, dialled in a different manner, dialled with additional options, etc.

b) If there is some form of UPT prefix (a number a calling party must dial before dialling a UPT number) it should be the same (or similar) across national and international boundaries, amongst UPT service providers, and across networks.

c) The UPT number should be as short as practicable in order to minimise the number of digits a calling party must dial.

d) The UPT number should be diallable and routeable from any terminal.

e) UPT subscribers should be able to retain their UPT number(s) whenever they change service provider.

f) In the long term, the UPT number should be usable across all networks, all terminals, and using any service.

g) The evolution of the UPT numbering plan should minimise the changes to UPT numbers.

The UPT service can be summarised as follows:

UPT enables users to access telecommunication services while (at the same time) allowing Personal Mobility.

UPT enables each UPT user to initiate and receive calls across multiple networks at any terminal and at any location.

The fixed association between terminal and user is removed.

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[33] ITU-T Rec. E.168 Application of E.164 numbering plan for UPT

Future Public Land Mobile Telecommunications Service (FPLMTS)

ITU-T has defined a third generation of mobile Communication Services, called FPLMTS. This service provides land mobile communications facilities similar to GSM, but on a global level and with a variety of different radio interfaces. In December 1994, it was agreed upon by ITU-T Study Group 2 that there was at present no need for a global numbering scheme for FPLMTS[34]. FPLMTS numbers will be based on national numbering resources, but with further development of FPLMTS, this statement may have to be revised. If FPLMTS is a global service, why not therefore also use global numbering resources? It seems that this question will be studied again in ITU-T during the current study period in order to find a stable solution for the future.

FPLMTS is also known within the ITU as International Mobile Telecommunications of the 2000's (IMT-2000). FPLMTS and IMT2000 are interchangeable terms referring to the same issue.

FPLMTS is a global mobile telecommunications system.

Today, FPLMTS is planned to be numbered from national resources.

FPLMTS numbering will be reviewed by ITU-T in the coming years.

Universal Mobile Telecommunications System (UMTS)

The Universal Mobile Telecommunications System (UMTS) is the realisation of a new generation of mobile communications technology for a world in which "Personal communication services will allow person-to-person calling, independent of location, the terminal used, the means of transmission (wired or wireless) and the choice of technology. Personal communication services will be based on a combination of fixed and wireless/mobile services to form a seamless end-to-end service for the user".

Although UMTS and FPLMTS have a similar approach, namely, to meet the demand of user mobility (by using terminal mobility), they should not be considered as identical[35] - for example, the introduction and implementation of multimedia/broad-band services is planned on different time scales.

UMTS is currently under development within ETSI and the RACE Programme and should support full personal communications services, spread over a combination of fixed and mobile networks. The European standardisation body ETSI is promoting UMTS as a third generation mobile communication service. The aim of UMTS is to integrate all mobile services into one network and to use broadband services. No decision has been taken up to now on how to number UMTS.

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[34] ITU-T Report COM 2-R 19-E Study Group 2 paragraph 3.5.2 ".....FPLMTS would be numbered in accordance with national numbering plans. There is no need, at the present time, for a Global numbering scheme...."

[35] ETSI Draft ETR 050201 SMG Framework for services to be supported by the Universal Mobile Telecommunications System (UMTS) September 1994

The European initiative to develop UMTS must be seen as part of a policy to provide an advanced, transparent, fully interoperable and integrated personal communications service across the continent. UMTS is not a replacement for 2nd generation technology (e.g. GSM, DCS 1800, DECT, etc.) which must be allowed to achieve its full potential. UMTS is a system that will support integrated personal and terminal mobility and offer broadband communications capability to meet the requirements of users and services of the 21st century.

UMTS, along with its international counterpart FPLMTS, extends the vision of personal mobility to include a universal mobile-telecommunications dimension with an integrated satellite component.

The Universal Mobile Telephone Service (UMTS) can be characterised as follows:

- UMTS will be the mobile access part of the B-ISDN.
- UMTS provides a technically integrated, comprehensive and consistent system of personal communications for both fixed and mobile terminals.
- UMTS could be a European FPLMTS solution.

So far there have been no decisions on the numbering of UMTS. ETSI has drafted "UMTS Service Requirements for Numbering and Addressing and Identification"[36]. According to ETSI, the following numbering requirements should apply to UMTS numbering from the calling user's perspective:

- The number dialled to reach a UMTS user should be easily recognisable and should be distinguishable from a non-UMTS number. This informs the calling user that he may be subject to specific arrangements (e.g. for charging)
- An International Mobile User Number (IMUN) that uniquely and unambiguously identifies each UMTS User. It is used by a calling party to reach the UMTS user. This number has no security implications, as it is a public number, conforming to E.164. This number is independent of terminal, network or service used and must conform with E.164.

Portability of the IMUN, the UMTS number, between service providers, within a Country Code (i.e. national), is a requirement of UMTS. The range of the allowed UMTS number portability may be categorised as follows: 1) Local area number portability, 2) National UMTS number portability, 3) Global UMTS Number portability. However, it is not yet clear which of these is an essential prerequisite to the introduction of UMTS.

UMTS is a network-oriented approach, which makes it possible to combine different wireless technologies under one umbrella. From our understanding today, numbering of UMTS itself is not based on Personal Numbers - only normal NTPs are needed. It is obvious that it is always necessary for NTPs to exist in one form or another.

How does PCS fit with the UMTS approach? One answer could be to consider UMTS as a physical network and to treat it in the same manner as any other physical network. UMTS handsets are then used as NTPs of the UMTS network.

UMTS is an NTP-oriented network.

UMTS numbers must conform to Recommendation E.164.

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[36] ETSI draft ETS SMG-0510201-09 version 0.2.0; 25 September 1994: Universal Mobile Telecommunication System (UMTS) Service Requirements for Numbering Addressing and Identification

Satellite Personal Communication Services (S-PCS)

Satellite Personal Communication Services (S-PCS) is a concept of a Personal Communication Service provided by means of satellite transmission. S-PCS may be considered as a sub-set of PCS in which the means of transmission are satellite links. S-PCS is a generic concept based on satellite services.

S-PCS is a range of radiocommunication-based public services offered to end users, where there is direct communication from terminal equipment, including hand-held terminals, to satellites.

> S-PCS is a sub-set of PCS, based on services offered through satellite links.

According to the European Commission[37]:

- Access to S-PCS systems should comply with the PCS access mechanism. S-PCS should not be numbered separately from PCS but its numbers should be embedded in PCS schemes.
- The demand for S-PCS is unclear. As demand grows, more numbering resources should be progressively made available.
- If numbers are allocated from the global Country Code resource, their exclusive application for S-PCS must be pursued. The possibility of using such codes for global service access by broader applications should be specifically excluded.

The telecommunications industry believes that over 95% of all dialled access to S-PCS will be through inter-system roaming and dialled access to terrestrial (GSM) networks.

Global Mobile Satellite System (GMSS),
Satellite Personal Communications Network (S-PCN)

Global Mobile Satellite System (GMSS) operators plan to offer public telecommunications services on a global basis via multi-satellite constellations[38]. When comparing GMSS with S-PCS and S-PCN (Satellite Personal Communications Network), it is difficult to establish a tangible difference between them. Therefore, the terms S-PCN, S-PCS and GMSS describe the same issue and could be seen as equivalent.

The intention of GMSS operators is to form an integral part of the international public switched telephone network. There are currently four GMSS operators: Odyssey, Iridium, I-CO and Globalstar. These operators are developing their services independently. It can be said that GMSS is today based on technological rather than service elements. The GMSS operators initially plan to provide, on a global mobile basis, the International Telephone Service as detailed in ITU-T Recommendation E.105 for their respective customers.

This service offering is intended for the global mobile community and for locations where the land-based infrastructure cannot provide such services. GMSS operators intend to provide telephone services to subscribers, who are expected to use hand-held terminals, dedicated either to GMSS operators or with a dual mode capability and land mobile systems. If the compatible cellular system in which the user is currently located is not available, the GMSS user will communicate directly with a GMSS satellite.

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[37] European Commission, Brussels 16 October 1995; Subject: Numbering Principles S-PCS

[38] Annex 3 of ITU-T Com 2-R 33-E; Document developed by I-CO, Iridium and Odyssey: "Potential assignment criteria applicable to global mobile-satellite operators"

> GMSS, S-PCN and S-PCS are different terms used to describe the same issue.
>
> GMSS will be the satellite part of personal mobility provision.
>
> GMSS is a technological rather then a service-based system.
>
> GMSS provides services for individual and dual mode terminals.

Cordless Terminal Mobility (CTM)

The Cordless Terminal Mobility (CTM) service allows users of cordless terminals to be mobile within and between networks. Where radio coverage is provided and the cordless terminal has the appropriate access rights, the user shall be able to make calls from, and to receive calls at, any location within the fixed public and/or private networks and may move without interruption of a call in progress[39]. This service enables a CTM user to roam within and between residential, business and public access areas. In phase 1, only telephony 3.1 kHz audio is supported.

CTM can be seen as a development of the following steps[40]:

- Cordless telephone: cordless telephone uses radio link, with a range of around 200 meters, in place of the flexible cord to link telephones handset to its base unit,
- Cordless telecommunications systems: replacement of the cordless telephone, i.e. system typified by a single base unit but often with a number of cordless terminals,
- Cordless Private Integrated services Network eXchange (PINX): allowing multiple base stations to be controlled as a single system,
- Cordless Private Integrated Services Network (PISN) Cordless Terminal Mobility: is a natural extension of the concept of the PINX, allowing cordless terminal users, with a single service registration and directory number, to roam within the radio coverage of different PINXs within the PISN,
- Public ISDN Cordless Terminal Mobility: allows individual cordless terminals to be registered to a public ISDN so that calls can be made to and from the individual terminals via the different residential, small business or public base stations that are connected to the public ISDN exchanges,
- Cordless Terminal Mobility: CTM integrates the concept of the PISN and ISDN allowing cordless terminal users, with a single public or private network service registration and directory number, to roam within the radio coverage of different public and private networks,
- Dual mode CTM and GSM services: Many mobile telecommunication users already use cordless telephones in their homes and/or workplaces, and cellular telephones when it is not convenient to use cordless ones. It is clear that there are advantages of both services and that neither service is ideal for all users. A number of manufactures are already developing dual mode cordless and cellular terminals, e.g. both DECT and GSM capabilities in a single terminal.

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[39] Draft ETSI DE/NA-010039 version 6, 2 October 1995: Cordless Terminal Mobility (CTM) - Phase 1; Service Description

[40] Changing the emphasis from Cordless Telephones to Cordless Terminal Mobility (CTM) and Examining the Progress on the standards for CTM: Graham Crisp, IIR Conference, London, September 1995

Numbering of CTM is based on national numbering schemes. According to ETSI, CTM numbers can be non-geographic numbers according to the operator's choice. It may be possible for users of the CTM service to keep their existing E.164 numbers as a network option.

As regards dual mode terminals, both CTM and GSM services depend on some form of centralised service control and database function to control the service and manage the mobility of the terminals. ETSI committees responsible for GSM standards are considering the use of IN in GSM networks. It is, therefore, feasible to consider the integration of the service and data functions of CTM with the Home Location Register of GSM in order to support the service provided to a group of hybrid CTM/GSM users. This would allow users to have a single service registration and directory number for both CTM and GSM. Two numbers exist within the network in any case; but only one number has to be known to the user, the second number is hidden in the network.

CTM numbering is based on National Numbering Schemes.

CTM numbers can be non-geographic numbers. If geographic numbers are used to number CTM, they lose their geographic nature as a result of terminal mobility.

The use of a single number for dual CTM/GSM-terminals requires some degree of integration of CTM and GSM networks.

For the operation of dual mode CTM/GSM-terminals, two numbers are required but only one is known to the subscriber.

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Annex F   Summary of PCS Network Elements

The following table summarises different network elements and their status regarding numbering.

Network type	Network / Service / Standard	ITU-T Rec.	Numbering resources used	Network technology
Fixed	POTS + ISDN	E.164	national	$\Rightarrow$ IN
Fixed	PSDN	X.121	national	?
Fixed	B-ISDN	E.191	national	$\Rightarrow$ IN
Wireless access to fixed	DECT	E.164	national	$\Rightarrow$ IN
Wireless	CTM	E.164 E.212	national	$\Rightarrow$ IN
Wireless	digital cellular mobile, e.g. GSM / DCS1800 / DCS1900	E.164 E.212	national	$\Rightarrow$ IN
Wireless	FPLMTS	E.164 E.212	national (under consideration)	$\Rightarrow$ IN
Wireless	UMTS	E.164 E.212	national?/ European?/global?	$\Rightarrow$ IN
Wireless	GMSS	E.164 E.212	global	$\Rightarrow$ IN
Wireless (fixed?)	PCS	E.164	national?/ European?/global?	needs IN capability
Wireless	S-PCS	E.164 E.212	national?/ European?/global?	$\Rightarrow$ IN
Fixed/wireless	International Freephone IFS	E.169	global	$\Rightarrow$ IN
Fixed/wireless	UPT	E.168 E.212	national/global	needs IN capability

Table 4 Network elements in PCS

Annex G   Terminal mobility / Personal mobility

In today's publications, the term "mobility" is used to describe the mobility of a user. Sometimes, however, these definitions are not precise enough. Mobility can be seen from two different viewpoints. One view relates more to the terminal and is called "terminal mobility", and the other relates more to the user and is called "personal mobility". Before going any further, both terms should be defined.

Terminal Mobility

Terminal mobility gives the user the opportunity to use the same terminal in different locations of a network. Terminal mobility is combined with the ability to access the network via some kind of radio access. The address of such a terminal is a Network Termination Point (NTP). Examples of these are present national GSM networks, in which a user can call or be called by using his handset, irrespective of where he is in the country. Due to roaming agreements between GSM operators, it is also possible to be reached in a foreign country through the use of the foreign GSM network. In areas where roaming agreements do not exist or where a GSM network has not been installed, it is not possible for users to use their own GSM terminal.

Definition   Terminal Mobility[41]

Terminal Mobility is the ability of the terminal to access telecommunication services from different locations while in motion, and the capability of the network to identify and locate that terminal. Terminal mobility is restricted to a specific type of network.

Personal Mobility

Personal Mobility gives the user the opportunity to use all terminals of any network and to send and receive calls from that particular terminal. Personal Mobility uses intelligence in the network to keep track of the user if he is moving around and to deliver his calls to an appropriate contact point. The location of a person called by his Personal Number is not known, but the network tracks the user during registration and maps his Personal Number with the number of the actual NTP. The Personal Number is not related to a specific network or location; the number must be independent of network and location.

Definition   Personal Mobility[42]

Personal Mobility is the ability of a user to access telecommunication services at any terminal on the basis of a personal identifier (e.g. the UPT number), and the capability of the network to provide those services delineated in the user's service profile. Personal mobility involves the network capability to locate the terminal associated with the user for the purpose of addressing, routeing and charging [...]

Personal mobility is independent of network, location (country) and technology. With personal mobility it is always necessary to map personal identity into an NTP.

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[41]   ITU-T Rec. F.851 Universal Personal Telecommunication (UPT) - Service Description (Service Set 1)

[42]   ITU-T Rec. F.851 Universal Personal Telecommunication (UPT) - Service Description (Service Set 1)

Annex H Present Situation and Plans for National Personal Number Services

The following table lists the number ranges of personal number services and mobile networks in European countries. This data was taken from responses to ETO and OVUM questionnaires on national numbering schemes and from other country responses.

Country	Access code for personal numbers (introduced/planned, include UPT) without prefixes			Access code for mobile numbers without prefixes	
	number range 7	number range 8	other number ranges	number range 6	other number ranges
Albania					38, 39
Andorra					
Austria		878		66, 67, 68	
Belgium	70				17, 75, 95
Bosnia and Herzegovina					
Bulgaria					1x?
Croatia				6x?	
Cyprus					
Czech Republic				601, 602, 603	
Denmark	702 (Tele Danmark)				2x, 30, 40
Estonia					5x
Finland	78				4, 50
France	7	804		60, 66	
Germany	700			161	17x
Greece					93, 94
Hungary				60	20, 30
Iceland	7x ?				8x
Ireland		81			8
Italy					33, 36
Latvia					92, 93, 94
Liechtenstein					
Lithuania					
Luxembourg					02
Macedonia					
Malta					
Moldova					
Monaco					
Norway		880			9
Poland					
Portugal			606	676	931, 936
Romania					
Russian Federation					901, 902
San Marino					
Slovak Republic	700				901, 903, 905
Slovenia					
Spain			04		07, 08, 09, 70, 89, 29
Sweden	70				70, 10
Switzerland	700 (trial)	878			77, 79
The Netherlands		87		62, 65, 66	
Turkey					5x2
Ukraine				06x	03x - 05x
United Kingdom	70			various	various
Vatican City					
Summary	10 countries	6 countries	2 countries	10 countries	24 countries

Numbering related to PCS in Europe
© European Commission

Annex I   Evolution Aspects

Evolution in this context means adding some extra digits in front of the existing international Personal Number in order to let it evolve from the existing number range to another number range. This is also known as retaining a number. For example, an evolution from national to global numbers may be effected by prefixing a global access code to the existing national Personal Number (expressed in an international format).

A fictive example: National UPT number: +447 abc def gh
                            Global UPT number: +878 447 abc def gh

Which evolution paths are needed?

Number evolution may benefit users wanting to expand the operating area of their Personal Number from the national level to the European or global level. Evolution from the national to the global level is defined in ITU-T Recommendation E.168. UPT is the only globally defined service for personal telecommunications. No other global personal telecommunications service has been defined so far. It may be questioned whether other personal services will be defined in the future. Is there any reason to consider evolution paths other than those defined for UPT? If PCS differs from UPT, would PCS develop into another global service? Although it may be unlikely that more global personal telecommunications services, other than UPT, will emerge, it does not mean that we can discard the possibility of such services being developed in the future. When introducing new personal communications services on a national or European level, the length and structure of such numbers should be considered bearing in mind the possibility for European/global evolution.

Three different evolution paths exist:
1. evolution from national to European level
2. evolution from national or European level to global level
3. evolution from national through European to global level

When possible evolution is managed by adding leading digits in front of the previous number, evolution from the national through European to the global level restricts the length of the Personal Number and is considered an irrelevant alternative here. The two remaining evolution paths are, therefore, the evolution from national to European level and the evolution from national or European level to global level.

Evolution from national to European level

If the access code for pan-European PNs is, for example, 4 digits, it leaves a maximum of 11 digits for national use, including the Country Code (CC). In countries with a 2 digit CC and a 1 digit identifier for PNs, the maximum number length of a PN is 8 digits. In countries with a 3 digit CC and a 1 digit identifier for PNs, the maximum number length of a PN is 7 digits.

Evolution from national or European level to global level

If the length of the global access code is 3 digits, it leaves 12 digits to be used on a national or European level. The length of a national Personal Number depends on the length of the Country Code. In countries with 2 digit CCs and 1 digit identifiers for PNs, the maximum national number length of 9 digits gives a number capacity of one billion individual Personal Numbers. In countries with 3 digit CC and 1 digit identifiers for PNs, the capacity is 100 million numbers. If the European access code for Personal Numbers is four digits (e.g. 388X), the maximum length of European Personal Numbers is 8 digits, enabling 100 million individual numbers.

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Annex K   List of Abbreviations

ATM	Asynchronous Transfer Mode
B-ISDN	Broad-band-ISDN
CC	Country Code
CEC	Commission of the European Community
CEPT	European Conference of Postal and Telecommunications Administrations
CTM	Cordless Telephone Mobility
DCS1800	Digital Communication System on 1800 MHz (European approach)
DCS1900	Digital Communication System on 1900 MHz (US approach)
DECT	Digital European Cordless Telecommunications
ECMA	Standardising Information and Communication Systems
ECTEL	The European Telecommunications and Professional Electronic Industry
ECTRA	European Committee on Telecommunications Regulatory Affairs
ECTRA PTN	ECTRA Project Team on Numbering
EIIA	European Information Industry Association
ENF	European Numbering Forum
ETNO	European Public Telecommunications Network Operators' Association
ETNS	European Telecommunications Numbering Space
ETO	European Telecommunications Office
ETSI	European Telecommunication Standardisation Institute
FPLMTS	Future Public Land Mobile Telecommunication Systems
GMSS	Global Mobile Satellite System
GSM	Global System for Mobile Communication
IN	Intelligent Network
INTUG Europe	INTUG Europe (International Telecommunications Users Group)
ISDN	Integrated Services Digital Network
ITU	International Telecommunication Union
ITU-T	International Telecommunication Union Standardisation Sector
MoU	Memorandum of Understanding
NDC	National Destination Code
NTP	Network Termination Point
PCN	Personal Communications Network
PCS	Personal Communications Services
PLMN	Public Land Mobil Network
PN	Personal Number
POTS	Plain Old Telephony Service
PSDN	Public Switched Data Network
S-PCN	Satellite Personal Communications Network
S-PCS	Satellite Personal Communications Services
SIM	Subscriber Identity Module
SN	Subscriber Number
UMTS	Universal Mobile Telecommunications System
UPT	Universal Personal Telecommunications

Annex L   Comments of ENF members

ECTEL provided comments (attached to this report) on the 2. Second Interim / Draft Final report. The comment regarding Statement 20 has been taken into account in the Final Report.

ETNO NI provided comments (attached to this report) on the 2. Second Interim / Draft Final report.