



Electronic Communications Committee (ECC)
within the European Conference of Postal and Telecommunications Administrations (CEPT)

FIXED-MOBILE CONVERGENCE
with survey of
NUMBERING RELATED ISSUES

Ljubljana, October 2008

FIXED-MOBILE CONVERGENCE
with survey of
NUMBERING RELATED ISSUES

EXECUTIVE SUMMARY

The communications industry today is still largely divided between fixed network and mobile network communications. Operators found this strict separation to be a successful approach as long as the two technologies experienced steady, strong and profitable growth. Also economical matters justified the coexistence with different termination rates to these two network types. Both fixed and mobile carriers are today faced with declining margins. Fixed telecom operators are faced with the extra problem of consumers who are substituting a PSTN/ISDN phone for a GSM phone and making the GSM service their only telephone service. Mobile operators see their margins shrinking due to stricter regulation on termination tariffs, roaming charges and SMS.

Smooth cooperation between PSTN (Public Switched Telephone Network) and PLMN (Public Land Mobile Network) networks is one of the issues in electronic communications. The common use of these networks and above all, their services is known as "Fixed Mobile Convergence" (FMC). FMC is in this report understood as the term used to describe a wide range of mobile services that converge elements of fixed communications infrastructure to complement the core mobile service. Typically a user benefits higher transaction speed and cheaper calls from home or the office using fixed network capabilities, whilst taking advantage of overall mobile network coverage with higher call charges and, in many cases, lower transaction speed. The advantages for operators are also easy to see. Carriers expand the existing business by offering their customers attractive voice, data and video services as both mobile and fixed network solutions. In addition, future network architectures will have a common service and control level, which could lower the operating costs for the operators.

FMC is a converged fixed and mobile service that enables the user to access a wide variety of communication, information and/or entertainment services, with consistent quality of service regardless of the device used, the underlying network over which those applications run or the user's location. FMC is driven by the differences in tariffs for outgoing fixed and mobile calls and the growing availability of dual mode handsets that can use the more expensive mobile service and the cheaper fixed service.

The report answers to the following questions:

- What is meant by FMC?
- What are the relations between various types of convergence and FMC?
- What kind of numbering related regulatory aspects come along with FMC?
- What kind of numbering solutions could be considered for FMC?

The report draws the following conclusions:

- FMC is a limited commercial service, the primary objective of which is to reduce retail prices and to enable users to be more easily reachable.
- FMC is considered to be implemented as "dual mode linked service". In this model fixed and mobile operators collaborate to offer a single service and the network determines automatically which system is used and possibly provides handover between the different technologies. This option normally offers the subscriber the opportunity to make calls from home and places with hot spot coverage, at low fixed tariffs.
- As fixed network connections traditionally have been addressed with fixed (network) numbers and mobile network connections with mobile numbers, the full benefit of FMC can be reached when number portability between fixed and mobile networks has been introduced. One of the obstacles to portability between fixed and mobile numbers is difference between retail prices in calling to fixed and mobile networks.

The report recommends the following:

1. Usage of number ranges for FMC

Introduction of new number ranges should be limited to introduction to new services, only. As FMC combines existing services, and as introduction of new number ranges tends to be quite expensive in terms of opening these number ranges by the operators, and furthermore, requires a number change by the end user, which is not user friendly, it is not recommended to open a new number range for FMC.

It is recommended to use a mobile number for FMC services. However, a fixed number – in addition to a mobile number – could be used, but in countries where nomadic use of fixed numbers is not allowed this usage of a fixed number should be limited to the home-zone only.

2. CLI

Regarding the CLI the following options are recommended:

Option A: Emergency calls should always be conveyed in the mobile networks using a mobile number as the CLI. For other calls also the mobile number should be used as the CLI independent of the used network (fixed or mobile) to convey the call.

Option B: At home (the address connected with the fixed number subscription) calls should always be conveyed in the fixed network using a fixed number as the CLI. Anywhere else the calls must always be conveyed in the mobile network using a mobile number as the CLI.

3. Retail pricing

When dialling a fixed number for FMC service, then the consumer calling to an FMC user should not pay more than the fixed network tariff.

FIXED-MOBILE CONVERGENCE
with survey of
NUMBERING RELATED ISSUES

Table of contents

1 INTRODUCTION 5

2 SCOPE 6

3 DESCRIBING FIXED-MOBILE CONVERGENCE 7

 3.1 FMC CHARACTERISTICS 7

 3.2 USER ASPECTS 8

4 REGULATORY AND TECHNICAL ISSUES 9

 4.1 INTRODUCTION TO REGULATORY ASPECTS 9

 4.2 TECHNOLOGY NEUTRALITY 9

 4.3 INTERCONNECTION AND TARIFF RELATED ISSUES 9

 4.4 RETAIL PRICING ASPECTS 10

 4.5 CLI RELATED ISSUES 10

 4.6 ACCESS TO EMERGENCY SERVICES 11

 4.7 LEGAL INTERCEPTION 11

 4.8 NOMADICITY 12

 4.9 DIRECTORY ISSUES 12

5 NUMBERING ASPECTS 12

 5.1 INTRODUCTION TO NUMBERING ASPECTS 12

 5.2 NUMBERING OPTIONS 13

 5.3 INTRODUCING NEW NUMBERING RANGES, CC OR NDC 14

 5.4 CARRIER SELECTION AND CARRIER PRE-SELECTION 15

 5.5 NUMBER PORTABILITY 15

6 CONCLUSIONS AND RECOMMENDATIONS 16

 6.1 CONCLUSIONS 16

 6.2 RECOMMENDATIONS 17

7 ABBREVIATIONS 18

ANNEX 1: NETWORK, USER DEVICE AND SERVICE CONVERGENCE 19

ANNEX 2: NUMBERING OPTIONS WITHIN IMPLEMENTATION MODELS 23

ANNEX 3: ANALYSIS ON NUMBERING OPTIONS 38

FIXED-MOBILE CONVERGENCE **with survey of** **NUMBERING RELATED ISSUES**

1 INTRODUCTION

Smooth cooperation between PSTN (Public Switched Telephone Network) and PLMN (Public Land Mobile Network) networks is one of the issues in electronic communications. The common use of these networks and above all, their services is known as “Fixed Mobile Convergence” (FMC). FMC is in this report understood as the term used to describe a wide range of mobile services that convergence elements of fixed communications infrastructure to complement the core mobile service. Typically a user benefits higher transaction speed and cheaper calls from home or the office using fixed network capabilities, whilst taking advantage of overall mobile network coverage with higher call charges and, in many cases, lower transaction speed.

From the user’s point of view, a wide range of uniform services across fixed and mobile networks is very important. The combination of innovative network spanning FMC services with an attractive rating gives new impulses to the electronic communication market. The network operators and service providers differentiate themselves even more from the competitors with the new FMC services and to increase their market share.

The communications industry today is still largely divided between fixed network and mobile network communications. Operators find this strict separation to be a successful approach as long as the two technologies experience steady and strong growth. Also economical matters justify the coexistence with different termination rates to these two network types.

Both fixed and mobile carriers are faced with declining margins. Fixed telecom operators are faced with the problem of consumers substituting a PSTN/ISDN phone for a GSM phone and making the GSM service their only telephone service. Mobile operators see their margins shrinking due to stricter regulation on termination tariffs, roaming charges and SMS. Furthermore, mobile number portability has made it easy and attractive for users to change operators in looking for lower communications costs. The users want to get inexpensive telephone service and are thus encouraged to switch operators frequently to earn from generous switching offers. In essence, because of increased comfort of usage, many want to have a single terminal for all their telephony needs. This single terminal is quite naturally a mobile terminal with built-in telephone book and other advanced functionalities that traditional fixed network telephones seldom have. Users wish to be reachable anytime and anywhere and this is best achieved with a mobile phone. This trend is supported by still relatively high cost of a fixed telephone subscription, which is less and less used. In addition, users also want only one voice mail system and to receive a single bill for all services they use.

The aim is to provide both traditional “fixed network type” and “mobile network type” services with a single phone, which could switch seamlessly between networks, i.e. FMC. With the full convergence between the mobile and fixed networks, telecommunications operators can provide services to users irrespective of their location, access technology, and terminal equipment. The advantages for operators are also easy to see. Carriers expand the existing business by offering their customers attractive new voice, data and video services as both mobile and fixed network solutions. In addition, future network architectures will have a common service and control level, which could lower the operating costs for the operators. FMC will be facilitated by the adoption of Next Generation Networks (NGN), that will also combine different aspects of communication, including – as a very important feature of NGNs – IP based networks.

The [ECC Report 36](#) “*Implications for Numbering, Naming and Addressing of the Convergence of the Internet and the Telco Networks*” discusses widely the general concept of convergence as quoted below. Figure 1 illustrates the process of convergence as understood in the ECC Report 36:

“Convergence is not a simple process. Technologically networks are converging on the use of IP technology but the methods of managing the networks and the provision of services differ significantly, and the telco and internet business models are coming increasingly into competition with each other. From a market perspective, convergence means that organisations that previously worked in distinct areas are increasingly becoming able to provide a wider range of services and compete with each other.”

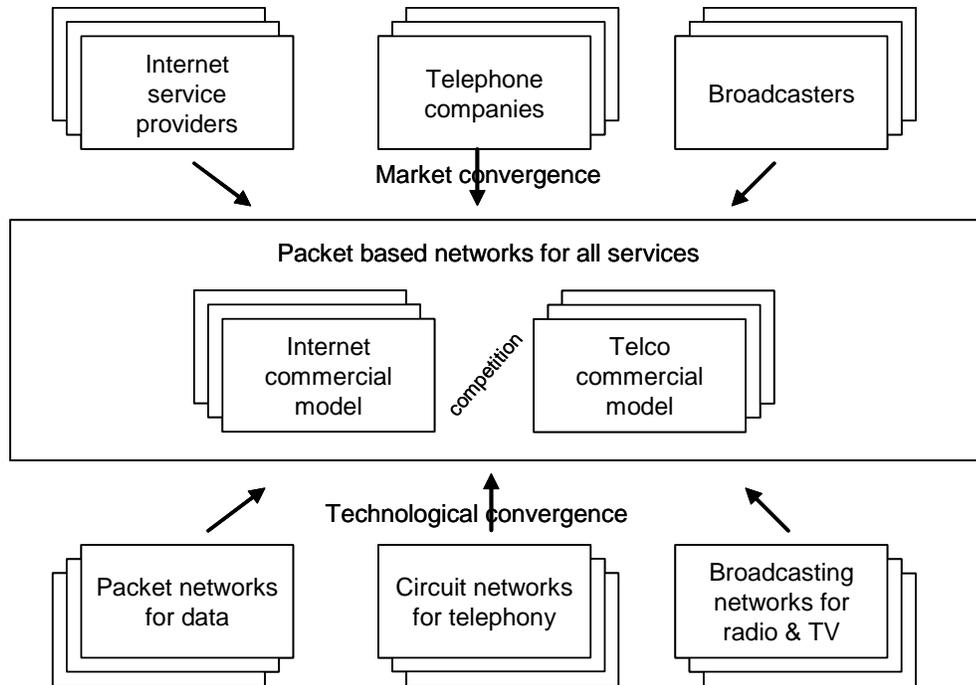


Figure 1: The process of convergence (Source: ECC Report 36)

2 SCOPE

This report is written by the Working Group Numbering, Naming and Addressing (WG NNA) and thus it is natural that the report discusses FMC from numbering, naming and addressing point of view. To be able to do this, a wider starting point is needed. Numbering is heavily interrelated with other issues, such as interconnection, retail tariff, competition issues, consumer protection, calling line identification, etc. To understand the big picture the report takes a look to FMC beyond numbering.

FMC is discussed as its widest concept, which means that different wireline (cordless) and wireless access methods are considered as well as different types of core networks serving these access methods. Note, that here the meaning of “cordless” is connected with the fixed network (cordless extension of fixed line telephone, e.g. at home), while “wireless” is connected to mobile networks.

From a numbering point of view, this Report tries to define the most adequate numbering ranges that can be used to accommodate FMC Services. Convergence issues, such as network convergence, user device convergence and service convergence are described in Annex 1.

3 DESCRIBING FIXED-MOBILE CONVERGENCE

3.1 FMC Characteristics

ITU-T Recommendation Q.1762/Y.2802 “*Fixed Mobile Convergence General Requirements*” defines the following:

“Fixed Mobile Convergence: in a given network configuration, the capabilities that provide services and application to the end user [defined in ITU-T Y.2091¹] regardless of the fixed or mobile access technologies being used and independent of the user’s location. In the NGN environment [ITU-T Y.2011²], it means to provide NGN services to end users regardless of the fixed or mobile access technologies being used.

Fixed Network: A network that provides wire-based (e.g. copper, fiber) or wireless access to its services. The fixed network may support nomadism, but does not support mobility.

Mobile Network: A network that provides wireless access to its services and supports mobility.”

FMC is required to support that a service provider is able to define the preferred access network for service delivery in case the user has both fixed and mobile coverage. A user may indicate via the terminal device the preferred access network for access to services. The service provider defines the policy regarding when handover between access networks is required to occur.

A converged fixed and mobile service is one that enables the user to access a wide variety of communication, information and/or entertainment services, with consistent quality of service regardless of the device used, the underlying network over which those applications run or the user’s location.

A FMC service will usually have one or more of the following characteristics:

Seamlessness. Seamlessness can be achieved at the device, network and/or service level. At the device and network level, it is in call handover: calls originating on the fixed network can move to a wireless network and vice versa, or between different wireless networks such as WiFi and mobile networks without interrupting the service. At the network level, it is transferring applications from one network platform to another, without the need for complicated encoding or translation.

User flexibility in access methods. Convergence services and devices will enable customers to use the most appropriate access access technology, such as WiFi or mobile networks, based on criteria such as current location, required application, quality of service and usage tariffs.

Converged Customer Premises Equipment (CPE). The availability of converged CPE will enable customers to move between access types more easily. Current users generally have a fixed-line phone for low-cost voice and fast internet access and a mobile phone for wireless voice and data applications such as SMS and MMS. Enterprise users commonly have even more devices than this such as a smart phone and a laptop for mobile data. However, the emergence of converged CPE such as WiFi phones will allow users to use one device for the applications they currently can access only by using several devices.

Personalisation. FMC services allow the end user to decide on the set of services they receive as well as the look and feel of the device’s user interface. The availability of converged CPE will give users a unified identifier. For example, rather than having to configure a fixed handset and a mobile handset twice, each with the same set of services such as personalised address books, the users will only have to do this once for one device. Personalisation today is associated mainly with the mobile world, as mobile handsets include a greater variety of personalisation options than fixed handsets. FMC will bring personalisation into the fixed-line environment.

Different types of convergence are introduced in Annex 1: network convergence, user device convergence and service convergence.

1 ITU-T Y.2091: Terms and definitions for Next Generation Networks

2 ITU-T Y.2011: General principles and general reference model for Next Generation Networks

3.2 User Aspects

From a user’s perspective FMC has two inherently different service needs:

- A personal communication service with a personal identifier – a need to call a specific individual. Mobility is very important. Nomadicity can in practice provide some of the functions for the user that would be alternative to mobility.
- A function or non-personal communication service – a need to call a company or department or a household (anyone in the building) rather than a specific individual. Lines are often shared between several users in this case. Mobility can be used as part of a service.

These differences are inherent in the users need for communications and they will not disappear or converge. In practice at present we have:

- Different network types (fixed and mobile) with different number ranges.
- Different tariffs for each network type for making outgoing calls.
- Different tariffs for each network type for others to call the user (due to cost based termination).

Users make use of the current networks in the way that they think will best meet their real needs – some users do this with good information and great effort and ingenuity, others with less. Not all users make optimal decisions.

Dual mode terminals are becoming available with both ‘mobile and cordless’ or ‘mobile and WiFi’. FMC can be understood as the steps that operators are taking to combine or link their services with dual mode terminals to provide services that are either cheaper or better match the needs of some users – not all users.

With this analysis several phenomena can be commented:

- Substitution of mobile for fixed is what users do when they need a personal service and can afford a mobile phone for all their calls and so no longer need a fixed phone as a cheap alternative to a mobile.
- Dual mode handset with user control of the two separate services is for the user who needs a mobile service having the ease of a single handset but still using the fixed phone for cheaper calls on what is really an alternative to a personal mobile service. The cheaper mode can be either fixed cordless or VoIP via WiFi.

The numbering problem arises because a user who really wanted a personal mobile service started for cost reasons (mobile was very expensive) with two separate services with two separate numbers and are gradually moving to a single service but want to retain both numbers. In other words there is a progression; one likely example could be described as follows:

Step	Service	Accesses	Numbers	Bills	Terminals
1.	One fixed service as a poor personal service	1	1	1	1
2.	Separate fixed and mobile services each with its own terminal	2	2	2	2
3.	Separate fixed and mobile services but common terminal under user control	2	2	2	1
4.	Linked services with single bill	2	2	1	1
5.	Mobile service only	1	2	1	1
6.	Mobile service only	1	1	1	1

The progression, however, can be skipped from step 1. to step 6. with number portability between fixed and mobile networks.

In the longer term if the tariffs for fixed and mobile become the same (incoming and outgoing) users who want a personal service would all use a mobile network. Thus dual mode handsets for voice traffic are a transitional economic phenomenon.

4 REGULATORY AND TECHNICAL ISSUES

4.1 Introduction to Regulatory Aspects

As the communications market is rapidly changing, regulators may need to review existing market definitions and other regulations to ensure that existing frameworks are not disincentive to the development of new services, and that existing frameworks treat new services in a technologically neutral way. As services between fixed and mobile networks are merging, there may be a need of combining market definitions of these two types of networks, as well.

Numbering policies may have to be reviewed to accommodate FMC services. Numbering aspects are discussed in chapter 5 of this report.

4.2 Technology Neutrality

The European Union's (EU) regulatory framework for electronic communications networks and services³ indicates the support for technology neutrality as follows: The convergence of the telecommunications, media and information technology sectors means that all transmission networks and services should be covered by a single regulatory framework.

This means that the EU regulatory framework is technology neutral, applying the same regulatory principles regardless of the specific technology involved, and is designed to be future proof, and to take account of the convergence of digital technologies that allow everything from phone calls to entertainment to be delivered over all sorts of networks to all sorts of devices – PCs, televisions, mobile phones, wireline and wireless technologies and more.

From the user's point of view the technology of the called party's subscriber connection is not important as long as the called party is reachable, the quality of the connection is good enough and the caller can find out the price ground for the call in advance. The price of the call for the calling party shall not depend on the called party's actions.

The principle of technology neutrality is also applicable to numbering resources. Today's national numbering plans in general distinguish between fixed and mobile network numbers. Some countries have also allocated numbers for VoIP based services.

4.3 Interconnection and Tariff Related Issues

The numbering and termination rate issues require consideration of how long the approach of cost based termination will be or should be continued. This approach is not used universally, for example it is not used in the USA or India, where fixed and mobile termination rates are low and similar.

There are the following problems with the cost based termination approach:

- It is incompatible with reciprocity when different operators have different costs for the same service, hence some new entrants are allowed to charge much higher termination rates than established operators.
- It is not technology neutral because costs relate to technology.
- The cost bases of fixed and mobile are not compared on an equal basis since with fixed the called subscriber pays for the access whereas with mobile the calling party pays for the called party's access.
- However this distinction is based more on tradition than on a fundamental difference in the cost and investment profiles since fixed operators invest in laying cables in a street independent of receiving orders from specific households and this is similar to installing a base station. Also at the retail level both fixed and mobile operators are offering a range of price formulas with different balances between subscription and call charges.
- A move from cost based termination to low or zero termination rates for all network types would give better justification for porting numbers between fixed and mobile networks and remove the issues of what to do with the changed cost base under the convergence arrangements considered here.

3 Directive 2002/21/EC of the European Parliament and of the Council on a common regulatory framework for electronic communications networks and services (Framework Directive)

If the approach is maintained that termination rates should be cost based, and if mobile access is significantly more expensive than fixed access, then, if mobile numbers are used and if some of the calls at least are delivered in practice via fixed technology, the cost base is reduced which could have an impact on the terminating rate of a service.

4.4 Retail Pricing Aspects

As the FMC subscriber concludes the contract with an FMC service provider which contains all the pricing related aspects, it is concluded that enough transparency is created for the FMC subscriber, that no additional measures are needed.

With FMC service the tariff transparency needs to be obeyed, i.e. when dialling a fixed number the fixed network tariffs shall be applied and when dialling a mobile number the highest tariff may be the mobile network tariffs.

4.5 CLI Related Issues

Calling Line Identification (CLI) today is a useful feature in communications, although it cannot always be trusted. The CLI usage in connection with emergency services is discussed in section 4.6.

Within FMC concept the question about CLI will be whether the CLI should be that of the fixed or mobile subscription. One of the most important features of the CLI is to return a call based on CLI information. Taking into account that calls to fixed numbers are in general cheaper than calls to mobile numbers, the called party would prefer to receive a geographical number as a CLI (returning a call based on CLI). However, from the FMC subscriber's point of view it probably would be more appropriate to give a mobile number as a CLI. If the FMC subscriber is outside of the home-zone⁴, he would need to forward the calls to the fixed number to follow him as well as to pay the forwarded leg himself. Furthermore, if the fixed line at home is shared with family members, it will not be acceptable to those family members staying at home not to be able to receive calls that would follow only one family member.

To give a user as many options as possible, one alternative for the CLI could be to allow the FMC subscriber to choose whether he wants to give the fixed or mobile CLI when calling from the home-zone. Outside home-zone the CLI should be the mobile number in countries where nomadic use of fixed numbers is not allowed; in other countries (e.g. in Austria, The Netherlands) a user may also use a geographical number as a CLI outside the home-zone. This report will not discuss the technical (signalling) solutions to allow this alternative. This alternative would probably be the chosen one for fixed operators providing FMC services.

For a mobile operator providing FMC services a mobile number as a CLI also from the home-zone would be a natural choice. Technically it would also be easiest to allow only one CLI independent of the calling party's location. Furthermore, roaming access network during a call from wireless coverage to mobile, or vice versa, would not raise further issues.

The CLI options depend quite naturally on the chosen numbering options for the FMC service. If only one number (a fixed, a mobile or a number from a new numbering range) is chosen for the service, the choice of the CLI is clear. The issue becomes more complex with usage of several numbers, and then there are following options:

CLI option A: If the feature is offered by a FMC operator, a FMC user may decide whether to use a fixed or a mobile number assigned to him as a CLI.

CLI option B: Only a number related to the actually used network of the call (i.e. a fixed number as the CLI from a fixed network or a mobile number as the CLI from a mobile network) can be used as a CLI.

CLI option C: Only 1 alternative for the CLI, chosen by the service provider, is available (i.e. *always* one of the following: a fixed number, a mobile number or a number from a new numbering range).

⁴ In this report home-zone is defined as the area covered by WiFi or corresponding technology in the home address.

4.6 Access to Emergency Services

In order to intervene efficiently, the emergency services need, in addition to identification of the calling person, the following information from the communications technology point of view at the moment a call arrives:

- the correct identification of the calling line (CLI) which is needed to call back the person in case the call was interrupted;
- the correct routing to the public service answering point serving a certain geographical area;
- accurate localisation information.

In traditional fixed networks (PSTN/ISDN) the localisation information and the identification of the calling line can normally easily be derived from the CLI. The main issue with mobile calls is receiving accurate location information. Also in some countries prepaid cards are anonymous which implies that it is impossible to determine the subscription information from the CLI, however, the localisation information can be still retrieved from the relevant mobile operator. In VoIP networks there is no simple way for the VoIP operator to identify the user's location in case of nomadic usage. Another problem is that once the user's location is known the VoIP operator needs to know to which public service answering point the call has to be routed, especially when the VoIP user is not in his home country.

From the general description it is quite clear that from the perspective of the emergency services traditional calls from the PSTN/ISDN meet all the requirements.

Traditionally⁵, when an emergency call arrives, the public safety answering point (PSAP) operator sees either a mobile number or a fixed number. In case of a fixed number the PSAP operator can simply consult a database to retrieve the address information of the calling party. In case of a mobile number the PSAP operator, in order to receive the location information based on the relevant mobile operator's base station information, has to contact the relevant mobile operator. If a mobile number was allowed to be used in a fixed network, the emergency centre PSAP operator would not be able to utilize the localisation information because of the missing radio leg and thus there is no base station information available. This is why a mobile number shall not be used from a fixed network to place an emergency call. If a fixed number was allowed to be used in a mobile network, the emergency centre PSAP operator would get the physical home address linked to the geographical number although, in practice, the caller's location could be anywhere. This is why a fixed number shall not be used from a mobile network to place an emergency call.

From the perspective of the emergency service a number in a new numbering range (for FMC) would facilitate to distinguish a FMC service from a "normal" fixed or "mobile" service.

For calls to emergency services there are the following options:

Option A: The calls should always be conveyed in the mobile networks using a mobile number as the CLI.

Option B: At home (the address connected with the fixed number subscription) calls should always be conveyed in the fixed network using a fixed number as the CLI. Anywhere else the calls must always be conveyed in the mobile network using a mobile number as the CLI. For calls which do not originate from home but a hotspot environment (VoIP) the normal national rules regarding calls to emergency services for nomadic services should be applied. Of course all this could be resolved if efficient databases exist which inform the emergency centre operators which network and service provider serves a specific number.

Today for calls to emergency services by residential users a network provided CLI should always be used.

It can be concluded that the capability of FMC operators to meet requirements for emergency services depends on the network architecture and is independent of the chosen numbering solution.

4.7 Legal Interception

On demand of law enforcement services operators are obliged to give the following information:

- for a specific number all the outgoing and/or incoming calls (CLI);
- duration of calls;

⁵ "Traditionally" means that a mobile number can only be used in a mobile network, and a fixed number in a fixed network.

- accurate location information;
- for mobile terminals in “silent mode” the localisation.

As long as the law enforcement services can be based on an E.164 the existing procedures can be applied. For mobile terminals the information needed by legal interception services has not only to be given based on the CLI but also on IMSI/IMEI.

It can be concluded that the capability of FMC operators to meet requirements for legal intercept depends on the network architecture and is independent of the chosen numbering solution.

4.8 Nomadicity

Nomadicity is a feature of a service that makes that the service is not linked to a particular physical location and that the service can be provided from potentially any fixed or mobile network endpoint in the world for incoming and outgoing communications [[ECC Report 59](#): Numbering for VoIP Services, Oxford, December 2004].

In this report nomadicity can be seen as an alternative for mobility, but it will not provide a handover function.

4.9 Directory Issues

Fixed network numbers have generally been listed in telephone directories based on an ‘opt-out system’⁶. In contrary, mobile numbers haven’t been listed. One of the reasons for this has been that fixed network operators have had “a monopoly” for directories, the fixed network having existed “always”. Another reason is that mobile network numbers are only listed, if the end user ‘opts-in’. When mobile networks emerged it was not economically feasible to start to publish a competing directory for relatively few numbers. As fixed and mobile network operators traditionally were competitors, there was no easy solution in finding one single directory for both fixed and mobile numbers.

If it is decided to use mobile numbers or numbers in a new numbering range for FMC and these services strongly develop, there might be directory issues, resulting from the use of the ‘opt-in system’. In case geographical numbers are used, it is likely there will be much less or no impact.

5 NUMBERING ASPECTS

5.1 Introduction to Numbering Aspects

In the last few years terminal manufacturers have started to market dual mode mobile terminals, which are capable of working with both cellular mobile and short range “hot spot” technologies such as WiFi. This development has created the possibility for a subscriber not only to have one dual mode phone but also to make and receive calls in either of two ways: via the fixed service or internet and via the mobile service. As the network operators increasingly plan to replace the PSTN service with IP-based networks, this model of combining mobile cellular and IP-based (fixed) networks via wireless access will most likely be one of the most used model for FMC concept. From numbering point of view the models described in this chapter may be applied in spite of the chosen fixed network technology, i.e. whether IP-based networks or PSTN are chosen.

There are three main FMC implementations:

- A. Dual mode separate service.** The user buys a dual mode phone and arranges himself service with the fixed and mobile operator separately. In this case the user selects which service to use taking account of his location and of tariffs when he wishes to make each call.
- B. Dual mode linked service.** Fixed and mobile operators collaborate to offer a single service and the network determines automatically which system is used and possibly provides handover between the different technologies. This option normally offers the subscriber the opportunity to make calls from home, with hot spot coverage, at low fixed tariffs. In some implementations the home-zone is extended to any location with internet access.

⁶ Sweden, Germany: opt-in for fixed and mobile; Norway: opt-out for fixed and mobile.

- C. **Single mode service.** The third option would be to use only one network, which will be a mobile network⁷. With, for example, a home-zone concept, the mobile network simulates the fixed network in the home-zone giving possibilities for lower priced calls.

Mobile operators are not only attempting to replace fixed services for the residential market but also for the business market with mobile office services that are similar to Centrex and VPNs but use mobile access and also provide short dialling between employees of the same organisation. Thus there is a variety of different scenarios and some users will wish to retain their existing arrangements and not use any of these new scenarios. This type of FMC approach is out of the scope of this report.

5.2 Numbering Options

In the three main FMC implementations there are different numbering options.

A. Dual mode separate service

The user retains the separate fixed and mobile numbers for fixed and mobile networks for both incoming and outgoing calls.

B. Dual mode linked service

Within this implementation there are four numbering options for both incoming and outgoing calls:

1. The use of the fixed number only.
2. The use of the mobile number only.
3. The use a new number in a different range especially for FMC service.
4. Any combination of options above.

C. Single mode service

Within this implementation there are four numbering options for both incoming and outgoing calls:

1. The use of the fixed number only.
2. The use of the mobile number only.
3. The use a new number in a different range especially for FMC service.
4. Any combination of options above.

The usage of the above mentioned numbering options is explained in more detail in Annex 2.

Numbering options for FMC follow the three main implementations stated in the previous chapter. When assessed, the numbering options will take both incoming and outgoing calls into account as illustrated in figure 2.

⁷ Not ruling out the possibility of fixed networks having mobility coverage in the future comparable to GSM.

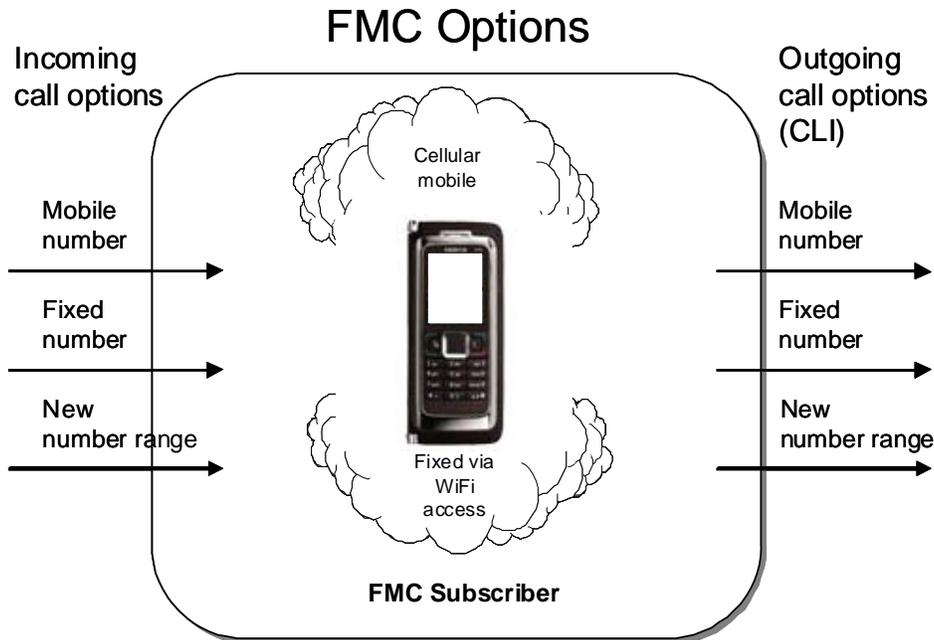


Figure 2: Illustration of FMC options with numbering alternatives for incoming and outgoing calls

Here, 'incoming calls' mean the calls that are received by the FMC user, who in this case is the called party. 'Outgoing calls' mean that the calls are placed by the FMC user, who in this case is the calling party.

Different numbering options are summarized in more detail in Annex 2. An analysis based on the options is given in Annex 3.

5.3 Introducing New Numbering Ranges, CC or NDC

As the numbering options for FMC described in chapter 5.2 include introduction of new number ranges, it is important to understand the consequences and the incurred costs for operators in opening of the new number ranges.

The introduction of a new number range involves much more than the allocation of the numbers by the NRA. It goes without saying that numbers are useless without the corresponding connectivity arrangements.

There are three different generic activities that may be involved:

1. Adding the number range to routing tables in the networks of both the serving and interconnected operators, and possibly some indirectly connected operators.
2. Assigning a termination rate to the number range and adding the range and the termination rate to each of the different interconnection agreements with other operators and to each of the interconnection billing systems.
3. Assigning a retail rate for calls to the number range and adding this rate to all the call rate information and the billing systems of all the operators that will apply this special rate to calls to the number range.

The costs and work involved (e.g. interconnection agreements) varies depending on where the new number range fits in the overall global system of numbering. At one extreme, if a new number range is added inside an existing range with established interconnection and charging arrangements, then there may be little work involved under 1) and no work under 2) and 3). As a middle of the road example, if a new range is added at the national level for a new service with a new termination rate then all the operators in the country concerned will be affected at least under 3) and many under 1) and 2). At the other extreme is the case of a new country code, e.g. +xyz, which will involve all international operators under 1) and 2) and all operators under 3).

Where the actions identified above are not undertaken there will be no connectivity and calls to the new number range will not be possible.

It is for these reasons that operators are unwilling to support new number ranges unless there is evidence that there will be sufficient traffic to justify the cost of the opening of the range.

In some cases new number ranges are opened provisionally with the intention that if there is no use in practice or a low level of use then the numbers will be reclaimed. If there is no use at all then there is no problem in reclaiming the numbers. However if there is some use and the parties who are using the numbers wish to continue, the withdrawal of the numbers will cause real losses or costs to the parties who are using them. Thus the approach of provisional allocation is not free of problems. Once services start on the new range it cannot be withdrawn without causing hardship.

There will probably be no significant change to these costs and issues with the introduction of NGN unless the operators/service providers change completely their commercial practices.

All these constraints contrast with the internet and its support of domain names. New names are added relatively easily through the domain name system without a need to change routing arrangements, interconnection or retail charges since charges are not dependent on the called name.

If it is decided to introduce a new number range for FMC in a national level, then all operators in the country will be affected.

It is quite logical that it takes a long time before end-users understand the service and retail tariffs linked to new number ranges. Therefore there will be some reluctance by end-users to dial these numbers.

5.4 Carrier Selection and Carrier Pre-selection

Significant market power fixed network operators maybe required depending to the market analysis to provide carrier selection and call origination services at cost based prices.

These requirements are also applicable if fixed network services are offered in mobile networks.

As a conclusion the provision of FMC service does not have any impact on carrier selection and carrier pre-selection.

5.5 Number Portability

Three types of number portability exist:

- Operator number portability: the end user can retain his number on the same service while changing service providers;
- Location number portability: the end user can retain his number while changing the geographical location inside a numbering area⁸ and retaining the service provider;
- Portability between fixed and mobile networks: the end user can retain his number while changing the services, e.g. from a fixed network to a mobile network.

There is a clear need for end users that they can keep their number while changing from fixed to mobile network and vice versa. But portability between fixed and mobile networks would mean that mobile users would be able to use their mobile numbers in a fixed network service, and vice versa. Furthermore, this would mean that it is not only home-zone users who would be able to take advantage on cheaper priced calls, if we look at the pricing structure between fixed and mobile today. A quick conclusion would be that at the eve of portability between fixed and mobile numbers, the termination rates between fixed and mobile networks would need to be harmonized. As termination rates are the main reason of price difference between fixed and mobile network calls (i.e. calls between fixed network and mobile network), it would be likely that the actual call prices thereafter would become very close to each other.

⁸ In some countries location number portability may be restricted to a part of numbering areas.

As soon as their termination rates become sufficiently close, provided that there is no distance dependent element within a country at the retail level, the number ranges for fixed and mobile could be merged for number portability purposes.

FMC does not imply portability between fixed and mobile networks/services.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The progress in electronic communication moves from the traditional PSTN towards personalized mobile service. FMC can be understood as development steps within this evolution. FMC is a service the primary objective of which is to reduce retail prices and to enable users to be more easily reachable.

In context of this report three implementation models for FMC have been defined: (A) dual mode separate service, (B) dual mode linked service and (C) single mode service. The implementation model (A) is described as “the user retains the separate fixed and mobile numbers for fixed and mobile networks for both incoming and outgoing calls”. This model is not considered a “true” FMC service. The implementation model (C) is using a mobile network only with a home-zone concept to simulate fixed network. Model (C) can be understood as a kind of pre-implementation of FMC service. Thus model (B) and its 7 numbering options (B1 – B7, see Annex 2) remains the most viable implementation model for FMC.

Numbering options for FMC concept include the use of a mobile number, a fixed number, both of them or a number from a new numbering range. Numbers used for incoming and outgoing calls increase complexity, not to talk about the number used as a CLI. As numbering for services should give a rough indication on tariff schemes and also on service type (i.e. mobile vs. fixed, for example) it is logical that the numbering for FMC follows the nature of this service as much as possible. FMC is not regarded as a new service.

Based on the analysis in the report it can be concluded that a number in a new numbering range will not be a user benefit because the end user cannot keep his existing number for that service. Furthermore, it is likely that introduction of a new numbering range for FMC use will cause operational and economical challenges for the operators. This leaves a mobile number, a fixed number or their combination to be recommended for the FMC use.

As long as the retail tariffs for calling fixed and mobile numbers are not more or less at the same level, usage of fixed number in mobile networks and vice versa is not recommended.

A mobile number for FMC would seem most clear from users’ point of view. Taking into account the FMC service’s highly mobile nature, the mobile number would serve best the characteristics of the service. Furthermore, the emergency services are used to handle mobile numbers with slightly more inaccurate location determination possibilities from the fixed numbers. Generally, the users understand the pricing structure within the mobile numbers. Therefore, the use of a mobile number for FMC is recommended. However, as a converged service, it is natural to take advantage of the home-zone approach within FMC. Thus, a fixed number – in addition to a mobile number – could be used, but in countries where nomadic use of fixed numbers is not allowed this usage of a fixed number should be limited to the home-zone only.

Regarding the CLI there are the following options:

Option A: Emergency calls should always be conveyed in the mobile networks using a mobile number as the CLI. For other calls also the mobile number should be used as the CLI independent of the used network (fixed or mobile) to convey the call.

Option B: At home-zone calls should always be conveyed in the fixed network using a fixed number as the CLI. Anywhere else the calls must always be conveyed in the mobile network using a mobile number as the CLI.

With FMC service the tariff transparency needs to be obeyed. As a fixed number may be used for FMC service, then the consumer calling to an FMC user should not pay more than the fixed network tariff.

The logical consequence of the above mentioned policy options is that of the provision of FMC services fixed operators will have access to mobile numbers and mobile operators will have access to fixed numbers.

6.2 Recommendations

These recommendations are given for the purpose of this report only, and they should not be mixed with ECC Recommendations (capital 'R') as regulative tools.

1. Usage of number ranges for FMC

Introduction of new number ranges should be limited to introduction to new services, only. As FMC combines existing services, and as introduction of new number ranges tends to be quite expensive in terms of opening these number ranges by the operators, and furthermore, requires a number change by the end user, which is not user friendly, it is not recommended to open a new number range for FMC.

It is recommended to use a mobile number for FMC services. However, a fixed number – in addition to a mobile number – could be used, but in countries where nomadic use of fixed numbers is not allowed this usage of a fixed number should be limited to the home-zone only.

2. CLI

Regarding the CLI the following options are recommended:

Option A: Emergency calls should always be conveyed in the mobile networks using a mobile number as the CLI. For other calls also the mobile number should be used as the CLI independent of the used network (fixed or mobile) to convey the call.

Option B: At home (the address connected with the fixed number subscription) calls should always be conveyed in the fixed network using a fixed number as the CLI. Anywhere else the calls must always be conveyed in the mobile network using a mobile number as the CLI.

3. Retail pricing

When dialing a fixed number for FMC service, the consumer calling to an FMC user should not pay more than the fixed network tariff.

7 ABBREVIATIONS

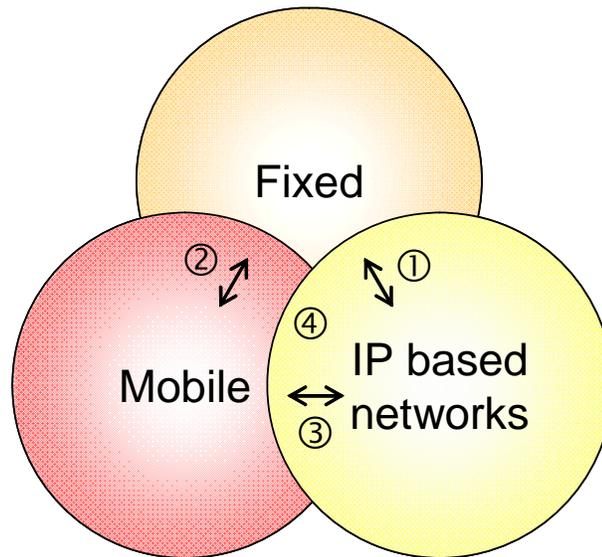
Abbreviation	Explanation
2G	2 nd generation mobile network, GSM
3G	3 rd generation mobile network, UMTS
CC	Country Code
CEPT	European Conference of Postal and Telecommunications Administrations
CLI	Calling Line Identification
CPE	Customer Premises Equipment
DECT	Digital Enhanced Cordless Telecommunications
DVB-H	Digital Video Broadcasting – Handheld
ECC	Electronic Communications Committee (within the CEPT)
EU	European Union
FMC	Fixed-Mobile Convergence
GSM	Global System for Mobile telecommunications
Home-zone	A defined location in the FMC concept, where the ‘fixed’ network access can be used
IEEE	Institute of Electrical and Electronic Engineers
IMEI	International Mobile Equipment Identity
IMSI	International Mobile Subscriber Identity
IN	Intelligent Networks
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ITU-T	International Telecommunication Union, Telecommunications Standardization Sector
MMS	Multimedia Messaging Service
MP3	MPEG-1 Audio Layer 3: an audio specific compression format
NDC	National Destination Code
NGN	Next Generation Networks
NRA	National Regulatory Authority
PDA	Personal Digital Assistant
PLMN	Public Land Mobile Network
PSAP	Public Safety Answering Point
PSTN	Public Switched Telephone Network
SFC	Service Control Function (of intelligent networks)
SMS	Short Message System
UMTS	Universal Mobile Telecommunication System
VoIP	Voice over Internet Protocol based networks
WG NNA	Working Group Numbering, Naming and Addressing (within ECC)
WiFi	Wireless Fidelity: a brand originally licensed by the WiFi Alliance to describe the underlying technology of wireless local area networks (WIFI) based on the IEEE 802.11 specifications
WiMAX	A technology enabling the delivery of last mile wireless broadband access as an alternative to wired broadband like cable and DSL

ANNEX 1: NETWORK, USER DEVICE AND SERVICE CONVERGENCE

Network Convergence

One of the basic elements in FMC is the ability for a user to utilize services independently from underlying network. Calls originating on the fixed network can move to a wireless network and vice versa, or between different wireless networks such as WiFi and 2G, with no interruption or change in service quality.

Fixed telephone network (PSTN/ISDN), mobile networks and wireless communication services (e.g. 2G, 3G, WiFi) and IP based networks form a set of today's communication networks. Figure A1 illustrates these networks and shows possible ways to understand convergence between them.



1. Convergence between fixed and IP based networks
2. Convergence between fixed and mobile networks
3. Convergence between mobile and IP based networks
4. Full convergence between fixed, mobile and IP based networks

Figure A1: Convergence possibilities between networks

Actually, when we talk about convergence, even about network convergence, the discussion is easily driven to convergence of services typical to various networks. This is natural, as it is rather unrealistic to think, in light of today's knowledge, that fixed, mobile and IP based networks – or even any pair of two of them – will merge into one core network in near future. A more likely development as a result from service migration will be that in the future there will be no difference between the networks but this development would be a result from service migration rather than network migration. Furthermore, a consequence of this would be discontinuation of certain types of networks, because the similar services can also be found in other networks maybe even with lower cost. Today's development suggests that the surviving networks will be IP based. It is clear that industrialized countries will pave the way for a single core network future, while existing networks will continue to be used still for decades in developing countries.

Based on the above thinking, we can conclude that network convergence is merely a hypothetical issue and, as such, does not require further study. Instead, we should look at how services are likely to migrate between

different types of networks, resulting in a form of 'service convergence'. There is room for discussion on whether 'convergence' is the appropriate term for services developed for one type of network and then provided on a different type. For example, is Voice over PSTN and Voice over IP converged services or are they two different services provided on two different networks?

User Device Convergence

Although many user devices increasingly get converged features, such as cameras in mobile phones, many of them still work for a single purpose. An ultimate example is a traditional fixed network telephone. On the other hand, the most advanced mobile phones act, in addition to being a telephone, as MP3 player, camera with video shooting possibility, internet browser and a PDA with document handling possibilities. Figure A2 illustrates convergence possibilities between different user devices.

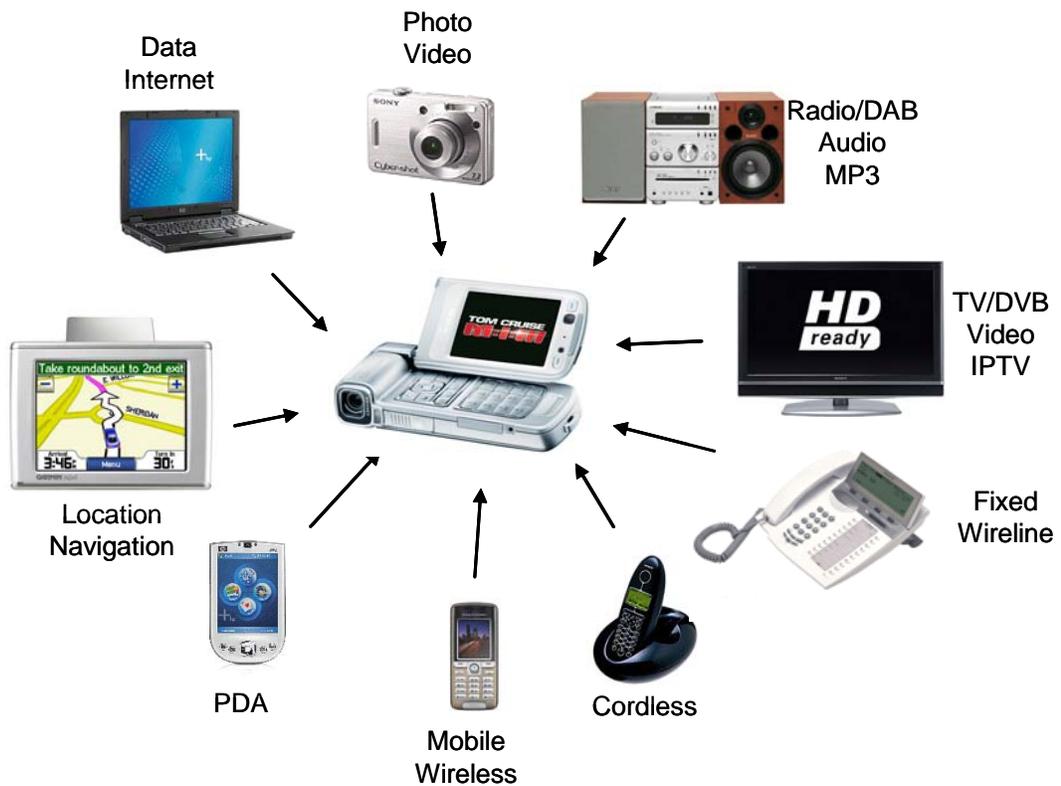


Figure A2: Convergence between user devices

Today, these converged devices could do more than what current infrastructure allows. For example, technically it is quite easy to show TV broadcasting (DVB-H) on the device. However, the technical and especially commercial agreements to broadcast TV signal into the mobile devices are still to be prepared.

One of the most important features within user devices to support convergence is the possibility to access different types of networks. It can be assumed that a user device is able to access a network using radio interface (i.e. wirelessly or cordlessly). Here, by *wireless access* a connection to mobile networks, such as 2G or UMTS, but also WiFi or WiMAX, is meant, and by *cordless access* a connection to fixed networks is meant, especially at home, but also in offices using, for example, Digital Enhanced Cordless Telecommunications (DECT) technology. DECT functioned indoors as a digital cordless telephone connected to a fixed network and outdoors

as a mobile phone using GSM technology. A possibility to access different types of networks is clearly a benefit to a user. Typically, at a home-zone utilizing a cordless protocol in accessing the fixed network, a higher transmission rate and lower communications costs are achieved. On the other hand, the same user device can be used outside the home-zone e.g. in WiFi hotspots to connect to the internet and use low cost or even free of charge voice over IP services. GSM coverage is widely available throughout the world and satellite telephony coverage can be reached in practice everywhere.

Another aspect of devices is that of *personal* and *shared use*. A call to a mobile phone is normally made with an expectation that the phone holder himself will answer the call. This expectation is supported by a personal voicemail where the person's voice greets the caller. Furthermore, a mobile phone typically allows a high level of personalisation which is not conducive to it being shared between users. In contrast, a fixed line telephone at home is generally considered as a piece of apparatus used by all the family, i.e. all persons living in a household. Traditionally, when a phone rings, the call may be addressed to any one in the family. Although individual ringing tones can be used for personalisation on a fixed line, this feature has never really become popular. The concept of FMC combines features from fixed and mobile communication. As mentioned, an important feature of mobile communication is its personalised aspect. If FMC offers the possibility of reaching a person on his fixed line number, then the personal aspect will be compromised as – instead of the intended person – a caller may end up talking with any of the family members. In many cases, of course, this will cause delay and inconvenience and may dissuade some users from subscribing to the fixed-mobile concept.

Service Convergence

As stated earlier in this Annex, when we talk about convergence, the discussion is easily driven to convergence of services typical to various networks. This is natural, as it is quite unrealistic to think, in light of today's knowledge that fixed, mobile and IP based networks will merge into one core network in near future. A more likely development will be that in the future there in fact will be only one core network, but this development would be a result from service migration rather than network migration. Figure A3 illustrates how migrating services between networks may result to a "service convergence" like concept.

It is a matter of definition, when we should talk about service *convergence*, service *migration* or just about *new* services that resemble each other, in different networks. Here, convergence of two (or more) services means that existing services are put together to form an enhanced service and the original services cease to exist. Migration of a service means that an existing service is developed further to be accommodated in another network. Note, that the term *service development* is used when a service is created or enhanced in the *same* network. Development of a new service can sometimes be very close to migration of a service. For example, has "Voice over PSTN" been migrated to IP based network (Voice over IP) or is "Voice over IP" a new service in a network other than PSTN?

In traditional networks the services were implemented *in* the network itself, typically in a network element. There are many examples about services implemented with intelligent network (IN) functionalities (e.g. by SFC, Service Control Function), such as number translation in routing of freephone calls.

Recently, in traditional networks and especially in next generation networks (NGN) services have increasingly been developed by third parties outside telecommunications companies (operators). A separate service platform, especially with open service interfaces, makes it easier to introduce existing services to other types of networks.

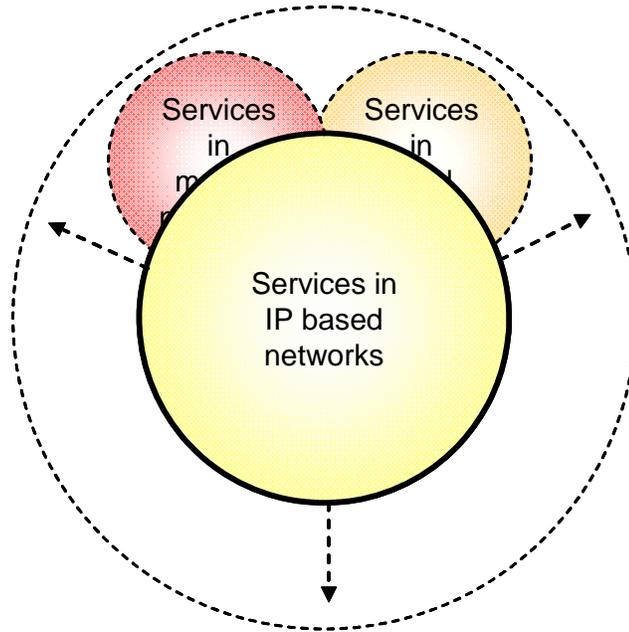


Figure A3: Migrating services between networks result in “service convergence”

The approach towards FMC can be described as different steps. In the first step services are bundled starting with voice services in fixed and mobile networks followed by those in mobile and IP based networks. After this step different additional services, such as single voice mailbox is offered for all voice services in spite of the network.

The second step will be FMC utilizing dual mode user devices, such as mobile phones with WiFi capabilities. This would allow, for example, home-zone services using WiFi modems to access VoIP through broadband connections. Tariffs in the home-zone tend to be in line with rates charged by fixed network operators and lower than cellular rates charged outside the home-zone. This approach results in services to be migrated and built increasingly for the IP based networks. Based on possible more aggressive service pricing structure, the services within traditional networks start to shrink away.

The third step would be to provide converged services in the converged core network as other networks cease to exist in lack of services, customers and revenue.

ANNEX 2: NUMBERING OPTIONS WITHIN IMPLEMENTATION MODELS

The numbering options in this Annex refer to implementation models introduced in chapter 5.1, namely:

- A. **Dual mode separate service.** The user buys a dual mode phone and arranges himself service with the fixed and mobile operator separately. In this case the user selects which service to use taking account of his location and of tariffs when he wishes to make each call.
- B. **Dual mode linked service.** Fixed and mobile operators collaborate to offer a single service and the network determines automatically which system is used and possibly provides handover between the different technologies. This option normally offers the subscriber the opportunity to make calls from home, with hot spot coverage, at low fixed tariffs. In some implementations the home-zone is extended to any location with internet access.
- C. **Single mode service.** The third option would be to use only one network, which will be a mobile network⁹. With, for example, a home-zone concept, the mobile network simulates the fixed network in the home-zone giving possibilities for lower priced calls.

A. DUAL MODE SEPARATE SERVICE	
Networks used	Mobile network and fixed network via wireless access by fully separate service providers independent from each other. The use of networks is arranged by the user.
Numbers used	Mobile number and fixed number
Incoming calls	Both networks and numbers can be used.
Fixed number	Calls to the fixed number of a FMC subscriber terminate at a given point, from where the FMC user may forward the calls at his own cost to other places, for example by using cellular mobile networks.
Mobile number	Calls to the mobile number use mobile network and act as normal calls to/within cellular mobile networks.
Outgoing calls	Both networks can be used.
Fixed network	Calls placed at the fixed network hot-spots may use the fixed network.
Mobile network	Calls placed outside hot-spots are using the mobile network.
CLIP ¹⁰ (the number displayed to the called party)	Both numbers can be used. The number of the used network will be used as the CLI, i.e. existing arrangements are applied. ¹¹
Retail tariff	
Calls to the FMC user	The network specific rates apply (same as to non-FMC user).
Calls placed by the FMC user	The network specific rates apply.
Interconnection	No impact.
Legal interception	No impact.
Access to emergency services	No impact.
Listing in directory services	No impact.
Remarks	

⁹ Not ruling out the possibility of fixed networks having mobility coverage in the future comparable to GSM.

¹⁰ CLI(P) regulations may vary from country to country.

¹¹ By contractual arrangements the subscriber may deviate from the rule that the CLI is the number from the used network only.

B1. DUAL MODE LINKED SERVICE: The use of a fixed number only	
Networks used	Mobile network and fixed network via wireless access. For incoming calls to the FMC user, the call termination is selected by the FMC user's service provider handling the number and forwarding the call according to the FMC user's preference. For outgoing calls the FMC service provider makes the choice of the used network. ¹² In some implementations the FMC service provider may allow hand-over between the networks.
Numbers used	The fixed number only.
Incoming calls	
Fixed number	The only option.
Mobile number	Not in use.
Outgoing calls	
Fixed network	May be used.
Mobile network	May be used.
CLIP (the number displayed to the called party)	The fixed number.
Retail tariff	
Calls to the FMC user	Same tariffs as to calls to a geographical number. If the call to the FMC user terminates in a mobile network, any added cost will be borne by the FMC user.
Calls placed by the FMC user	According to the terms of the FMC user's subscription of the used network.
Interconnection	Calls may terminate both in a fixed and a mobile network having an impact on termination rates.
Legal interception	No impact.
Access to emergency services	Impact on routing the call to the nearest emergency centre. May have an impact on location determination, as the fixed number may originate from a mobile network. The emergency centre needs to understand that call is originated from a mobile network. This information can be provided by various technical means.
Listing in directory services	A possible impact on listing a fixed number using a mobile network for conveyance.
Remarks	The impact of the use of the fixed number in mobile networks is portability from a fixed to a mobile network. This needs to be taken into account in numbering plans and has an impact on number assignment policies by extension of the scope of geographical numbers.

¹² The FMC user may also be given a possibility of choosing the network for outgoing calls.

B2. DUAL MODE LINKED SERVICE: The use of a mobile number only	
Networks used	Mobile network and fixed network via wireless access. For incoming calls to the FMC user, the call termination is selected by the FMC user's service provider handling the number and forwarding the call according to the FMC user's preference. For outgoing calls the FMC service provider makes the choice of the used network. ¹³ In some implementations the FMC service provider may allow hand-over between the networks.
Numbers used	The mobile number only.
Incoming calls	
Fixed number	Not in use.
Mobile number	The only option.
Outgoing calls	
Fixed network	May be used.
Mobile network	May be used.
CLIP (the number displayed to the called party)	The mobile number.
Retail tariff	
Calls to the FMC user	Same tariffs as to calls to a mobile number. A possible impact in case the FMC is connected to a fixed network and a caller is most likely still charged a mobile tariff. ¹⁴
Calls placed by the FMC user	According to the terms of the FMC user's subscription of the used network.
Interconnection	Calls may terminate both in a fixed and a mobile network having an impact on termination rates.
Legal interception	No impact.
Access to emergency services	Impact on routing the call to the nearest emergency centre. May have an impact on location determination, as the mobile number may originate from a fixed network. The emergency centre needs to understand that call is originated from a fixed network. This information can be provided by various technical means.
Listing in directory services	A possible impact on listing a mobile number using a fixed network for conveyance.
Remarks	The impact of the use of the mobile number in fixed networks is portability from a mobile to a fixed network. This needs to be taken into account in numbering plans and potentially impacts number assignment policies by extension of the scope of mobile numbers.

¹³ The FMC user may also be given a possibility of choosing the network for outgoing calls.

¹⁴ In some countries cost orientation for providers with SMP status is applied also to retail tariffs.

B3. DUAL MODE LINKED SERVICE: The use of a new number in a new numbering range	
Networks used	Mobile network and fixed network via wireless access. For incoming calls to the FMC user, the call termination is selected by the FMC user's service provider handling the number and forwarding the call according to the FMC user's preference. For outgoing calls the FMC service provider makes the choice of the used network. In some implementations the FMC service provider may allow hand-over between the networks.
Numbers used	The new number in a new numbering range.
Incoming calls	
New number in a new numbering range	The only option.
Fixed number	Not in use.
Mobile number	Not in use.
Outgoing calls	
Fixed network	May be used.
Mobile network	May be used.
CLIP (the number displayed to the called party)	The new number in a new numbering range.
Retail tariff	
Calls to the FMC user	A new tariff for a new numbering range will be defined. ⁶
Calls placed by the FMC user	According to the terms of the FMC user's subscription of the used network.
Interconnection	A new termination rate for the new numbering range needs to be defined.
Legal interception	No impact.
Access to emergency services	Impact on routing the call to the nearest emergency centre. May have an impact on location determination, as the new number may originate both from a mobile or a fixed network. Notwithstanding the emergency centre being aware the number belongs to an FMC service, it needs to understand which type of network the call is originated from. Location information can be provided by various technical means.
Listing in directory services	A possible impact on listing a new number from a new number range.
Remarks	The end user needs to change a number.

B4. DUAL MODE LINKED SERVICE: Combination of a fixed number and a mobile number	
Networks used	Mobile network and fixed network via wireless access. For incoming calls to the FMC user, the call termination is selected by the FMC user's service provider handling the number and forwarding the call according to the FMC user's preference. For outgoing calls the FMC service provider makes the choice of the used network. In some implementations the FMC service provider may allow hand-over between the networks.
Numbers used	A fixed number and a mobile number.
Incoming calls	
Fixed number	May be used.
Mobile number	May be used.
Outgoing calls	
Fixed network	May be used.
Mobile network	May be used.
CLIP (the number displayed to the called party)	The number of the used network. ³
Retail tariff	
Calls to the FMC user	When calling to a fixed number, same tariffs as to calls to a geographical number. If the call with a fixed number to the FMC user terminates in a mobile network, any added cost will be borne by the FMC user. When calling to a mobile number, same tariffs as to calls to a mobile number. A possible impact in case the FMC user is connected to a fixed network the caller is most likely still charged a mobile tariff.
Calls placed by the FMC user	According to the terms of the FMC user's subscription of the used network.
Interconnection	Calls may terminate both in a fixed and a mobile network possibly having an impact on termination rates.
Legal interception	No impact.
Access to emergency services	Impact on routing the call to the nearest emergency centre. May have an impact on location determination, as the fixed number may originate from a mobile network, and a mobile number may originate from a fixed network. The emergency centre needs to understand which network the call is originated from. This information can be provided by various technical means.
Listing in directory services	A possible impact on listing a fixed number using a mobile network for conveyance and vice versa.
Remarks	

B5. DUAL MODE LINKED SERVICE: Combination of a fixed number and a number in a new numbering range	
Networks used	Mobile network and fixed network via wireless access. For incoming calls to the FMC user, the call termination is selected by the FMC user's service provider handling the number and forwarding the call according to the FMC user's preference. For outgoing calls the FMC service provider makes the choice of the used network. In some implementations the FMC service provider may allow hand-over between the networks.
Numbers used	The fixed number and the number in a new numbering range.
Incoming calls	
Mobile number	Not in use.
Fixed number	May be used.
New number in a new numbering range	May be used.
Outgoing calls	
Fixed network	May be used.
Mobile network	May be used.
CLIP (the number displayed to the called party)	The number of the used network. ³
Retail tariff	
Calls to the FMC user	When calling to a fixed number, same tariffs as to calls to a geographical number. If the call with a fixed number to the FMC user terminates in a mobile network, any added cost will be borne by the FMC user. When calling to a number in a new numbering range a new tariff for this range needs to be defined.
Calls placed by the FMC user	According to the terms of the FMC user's subscription of the used network.
Interconnection	Calls may terminate both in a fixed and a mobile network possibly having an impact on termination rates. A new termination rate for the new numbering range needs to be defined.
Legal interception	No impact.
Access to emergency services	Impact on routing the call to the nearest emergency centre. May have an impact on location determination, as the fixed number may originate from a mobile network, and the new number may originate from both a fixed or a mobile network. Notwithstanding the emergency centre being aware the number belongs to an FMC service, it needs to understand which type of network the call is originated from. This information can be provided by various technical means.
Listing in directory services	A possible impact on listing a fixed number using a mobile network for conveyance and listing a new number from a new number range.
Remarks	Introduction of a new number to the user.

B6. DUAL MODE LINKED SERVICE: Combination of a mobile number and a number in a new numbering range	
Networks used	Mobile network and fixed network via wireless access. For incoming calls to the FMC user, the call termination is selected by the FMC user's service provider handling the number and forwarding the call according to the FMC user's preference. For outgoing calls the FMC service provider makes the choice of the used network. In some implementations the FMC service provider may allow hand-over between the networks.
Numbers used	The mobile number and the number in a new numbering range.
Incoming calls	
Mobile number	May be used.
Fixed number	Not in use.
New number in a new numbering range	May be used.
Outgoing calls	
Fixed network	May be used.
Mobile network	May be used.
CLIP (the number displayed to the called party)	The number of the used network. ³
Retail tariff	
Calls to the FMC user	When calling to a mobile number, same tariffs as to calls to a mobile number. A possible impact in case the FMC user is connected to a fixed network the caller is most likely still charged a mobile tariff. When calling to a number in a new numbering range a new tariff for this range needs to be defined.
Calls placed by the FMC user	According to the terms of the FMC user's subscription of the used network.
Interconnection	Calls may terminate both in a fixed and a mobile network possibly having an impact on termination rates. A new termination rate for the new numbering range needs to be defined.
Legal interception	No impact.
Access to emergency services	Impact on routing the call to the nearest emergency centre. May have an impact on location determination, as the mobile number may originate from a fixed network, and the new number may originate from both a fixed or a mobile network. Notwithstanding the emergency centre being aware the number belongs to an FMC service, it needs to understand which type of network the call is originated from. This information can be provided by various technical means.
Listing in directory services	A possible impact on listing a mobile number using a fixed network for conveyance and listing a new number from a new number range.
Remarks	Introduction of a new number to the user.

B7. DUAL MODE LINKED SERVICE: Combination of a fixed number, a mobile number and a number in a new numbering range	
Networks used	Mobile network and fixed network via wireless access. For incoming calls to the FMC user, the call termination is selected by the FMC user's service provider handling the number and forwarding the call according to the FMC user's preference. For outgoing calls the FMC service provider makes the choice of the used network. In some implementations the FMC service provider may allow hand-over between the networks.
Numbers used	The fixed number, the mobile number and the number in a new numbering range.
Incoming calls	
Mobile number	May be used.
Fixed number	May be used.
New number in a new numbering range	May be used.
Outgoing calls	
Fixed network	May be used.
Mobile network	May be used.
CLIP (the number displayed to the called party)	The number of the used network. ³
Retail tariff	
Calls to the FMC user	When calling to a mobile number, same tariffs as to calls to a mobile number. A possible impact in case the FMC user is connected to a fixed network the caller is most likely still charged a mobile tariff. When calling to a fixed number, same tariffs as to calls to a geographical number. If the call with a fixed number to the FMC user terminates in a mobile network, any added cost will be borne by the FMC user. When calling to a number in a new numbering range a new tariff for this range needs to be defined.
Calls placed by the FMC user	According to the terms of the FMC user's subscription of the used network.
Interconnection	Calls may terminate both in a fixed and a mobile network possibly having an impact on termination rates. A new termination rate for the new numbering range needs to be defined.
Legal interception	No impact.
Access to emergency services	Impact on routing the call to the nearest emergency centre. May have an impact on location determination, as the mobile number may originate from a fixed network, the fixed number may originate from a mobile network, and the new number may originate from both a fixed or a mobile network. Notwithstanding the emergency centre being aware the number belongs to an FMC service, it needs to understand which type of network the call is originated from. This information can be provided by various technical means.
Listing in directory services	A possible impact on listing a mobile number using a fixed network for conveyance, a fixed number using a mobile network for conveyance, and listing a new number from a new number range.
Remarks	Introduction of a new number to the user.

C1. SINGLE MODE SERVICE: The use of a fixed number only	
Networks used	Mobile network.
Numbers used	The fixed number only.
Incoming calls	
Fixed number	The only option.
Mobile number	Not in use.
Outgoing calls	
Fixed network	Not in use.
Mobile network	The only option.
CLIP (the number displayed to the called party)	The fixed number.
Retail tariff	
Calls to the FMC user	Same tariffs as to calls to a geographical number. Since the call to the FMC user terminates in a mobile network, any added cost will be borne by the FMC user.
Calls placed by the FMC user	According to the terms of the FMC user's subscription. Different tariff may apply to the calls placed in the home-zone.
Interconnection	Calls terminate on a mobile network with a fixed network number possibly having an impact on termination rates.
Legal interception	No impact.
Access to emergency services	Impact on routing the call to the nearest emergency centre. May have an impact on location determination, as the fixed number originates from a mobile network. The emergency centre needs to understand that call is originated from a mobile network. This information can be provided by various technical means.
Listing in directory services	A possible impact on listing a fixed number using a mobile network for conveyance.
Remarks	The impact of the use of the fixed number in mobile networks is portability from a fixed to a mobile network. This needs to be taken into account in numbering plans and has an impact on number assignment policies by extension of the scope of geographical numbers.

C2. SINGLE MODE SERVICE: The use of a mobile number only	
Networks used	Mobile network.
Numbers used	The mobile number only.
Incoming calls	
Fixed number	Not in use.
Mobile number	The only option.
Outgoing calls	
Fixed network	Not in use.
Mobile network	The only option.
CLIP (the number displayed to the called party)	The mobile number.
Retail tariff	
Calls to the FMC user	Same tariffs as to calls to a mobile number.
Calls placed by the FMC user	According to the terms of the FMC user's subscription. Different tariff may apply to the calls placed in the home-zone.
Interconnection	No impact.
Legal interception	No impact.
Access to emergency services	No impact.
Listing in directory services	No impact.
Remarks	

C3. SINGLE MODE SERVICE: The use of a new number in a new numbering range	
Networks used	Mobile network.
Numbers used	The new number in a new numbering range.
Incoming calls	
New number in a new numbering range	The only option.
Fixed number	Not in use.
Mobile number	Not in use.
Outgoing calls	
Fixed network	Not in use.
Mobile network	The only option.
CLIP (the number displayed to the called party)	The new number in a new numbering range.
Retail tariff	
Calls to the FMC user	A new tariff for a new numbering range will be defined.
Calls placed by the FMC user	According to the terms of the FMC user's subscription. Different tariff may apply to the calls placed in the home-zone.
Interconnection	A new termination rate for the new numbering range may need to be defined.
Legal interception	No impact.
Access to emergency services	As per mobile network originated emergency calls. The new number in a new numbering range may have an impact on location determination.
Listing in directory services	A possible impact on listing a new number in a new numbering range.
Remarks	The end user needs to change a number.

C4. SINGLE MODE SERVICE: Combination of a fixed number and a mobile number	
Networks used	Mobile network.
Numbers used	The mobile number and the fixed number.
Incoming calls	
Fixed number	May be used.
Mobile number	May be used.
Outgoing calls	
Fixed network	Not in use.
Mobile network	The only option.
CLIP (the number displayed to the called party)	Both numbers can be used.
Retail tariff	
Calls to the FMC user	When calling to a fixed number, same tariffs as to calls to a geographical number. Since the call to the FMC user terminates in a mobile network, any added cost will be borne by the FMC user. When calling to a mobile number, same tariffs as to calls to a mobile number.
Calls placed by the FMC user	According to the terms of the FMC user's subscription. Different tariff may apply to the calls placed in the home-zone.
Interconnection	Calls with a fixed number terminate on a mobile network possibly having an impact on termination rates.
Legal interception	No impact.
Access to emergency services	Impact on routing the call to the nearest emergency centre. May have an impact on location determination, as the fixed number originates from a mobile network. The emergency centre needs to understand that call is originated from a mobile network. This information can be provided by various technical means.
Listing in directory services	A possible impact on listing a fixed number using a mobile network for conveyance.
Remarks	The impact of the use of the fixed number in mobile networks is portability from a fixed to a mobile network. This needs to be taken into account in numbering plans and has an impact on number assignment policies by extension of the scope of geographical numbers.

C5. SINGLE MODE SERVICE: Combination of a fixed number and a number in a new numbering range	
Networks used	Mobile network.
Numbers used	The fixed number and the number in a new numbering range.
Incoming calls	
Fixed number	May be used.
Mobile number	Not in use.
New number in a new numbering range	May be used.
Outgoing calls	
Fixed network	Not in use.
Mobile network	The only option.
CLIP (the number displayed to the called party)	Both numbers can be used.
Retail tariff	
Calls to the FMC user	When calling to a fixed number, same tariffs as to calls to a geographical number. Since the call to the FMC user terminates in a mobile network, any added cost will be borne by the FMC user. When calling to a new number, a new tariff for this range needs to be defined.
Calls placed by the FMC user	According to the terms of the FMC user's subscription. Different tariff may apply to the calls placed in the home-zone.
Interconnection	Calls with a fixed number terminate on a mobile network possibly having an impact on termination rates. A new termination rate for the new numbering range needs to be defined.
Legal interception	No impact.
Access to emergency services	Impact on routing the call to the nearest emergency centre. May have an impact on location determination, as the fixed number originates from a mobile network. The emergency centre needs to understand that call is originated from a mobile network. This information can be provided by various technical means. The new number in a new numbering range may have an impact on location determination.
Listing in directory services	A possible impact on listing a fixed number using a mobile network for conveyance. A possible impact on listing a new number in a new numbering range.
Remarks	The impact of the use of the fixed number in mobile networks is portability from a fixed to a mobile network. This needs to be taken into account in numbering plans and has an impact on number assignment policies by extension of the scope of geographical numbers. Introduction of a new number to the user.

C6. SINGLE MODE SERVICE: Combination of a mobile number and a number in a new numbering range	
Networks used	Mobile network.
Numbers used	The mobile number and the number in a new numbering range.
Incoming calls	
Fixed number	Not in use.
Mobile number	May be used.
New number in a new numbering range	May be used.
Outgoing calls	
Fixed network	Not in use.
Mobile network	The only option.
CLIP (the number displayed to the called party)	Both numbers can be used.
Retail tariff	
Calls to the FMC user	When calling to a mobile number, same tariffs as to calls to a mobile number. When calling to a new number, a new tariff for this range needs to be defined.
Calls placed by the FMC user	According to the terms of the FMC user's subscription. Different tariff may apply to the calls placed in the home-zone.
Interconnection	A new termination rate for the new numbering range needs to be defined.
Legal interception	No impact.
Access to emergency services	The new number in a new numbering range may have an impact on location determination.
Listing in directory services	A possible impact on listing a new number in a new numbering range.
Remarks	Introduction of a new number to the user.

C7. SINGLE MODE SERVICE: Combination of a fixed number, a mobile number and a number in a new numbering range	
Networks used	Mobile network.
Numbers used	The fixed number, the mobile number and the number in a new numbering range.
Incoming calls	
Fixed number	May be used.
Mobile number	May be used.
New number in a new numbering range	May be used.
Outgoing calls	
Fixed network	Not in use.
Mobile network	The only option.
CLIP (the number displayed to the called party)	All numbers can be used.
Retail tariff	
Calls to the FMC user	When calling to a fixed number, same tariffs as to calls to a geographical number. Since a call with a fixed number terminates in a mobile network, any added cost will be borne by the FMC user. When calling to a mobile number, same tariffs as to calls to a mobile number. When calling to a new number, a new tariff for this range needs to be defined.
Calls placed by the FMC user	According to the terms of the FMC user's subscription. Different tariff may apply to the calls placed in the home-zone.
Interconnection	Calls terminate on a mobile network with a fixed network number possibly have an impact on termination rates. A new termination rate for the new numbering range needs to be defined.
Legal interception	No impact.
Access to emergency services	Impact on routing the call to the nearest emergency centre. May have an impact on location determination, as the fixed number originates from a mobile network. The emergency centre needs to understand that call is originated from a mobile network. This information can be provided by various technical means. The new number in a new numbering range may have an impact on location determination.
Listing in directory services	A possible impact on listing a fixed number using a mobile network for conveyance. A possible impact on listing a new number in a new numbering range.
Remarks	The impact of the use of the fixed number in mobile networks is portability from a fixed to a mobile network. This needs to be taken into account in numbering plans and has an impact on number assignment policies by extension of the scope of geographical numbers. Introduction of a new number to the user.

ANNEX 3: ANALYSIS ON NUMBERING OPTIONS

Fixed-mobile convergence allows a user to reach electronic communication services independent of his location, the used terminal equipment, access method or underlying network. Furthermore, FMC service is characterized as being seamless, having user flexibility in access methods, converging CPEs and having ability to being personalized.

Numbering options for FMC as described in chapter 5.2 are based on three implementations:

- A. Dual mode separate service
- B. Dual mode linked service
- C. Single mode service

The implementation model (A) is described as “the user retains the separate fixed and mobile numbers for fixed and mobile networks for both incoming and outgoing calls”. If all the previously mentioned is true, then the implementation model (A) will not be considered as “true” FMC service.

The implementation model (C) is using a mobile network only with a home-zone concept to simulate fixed network. In light of previously mentioned model (C) can be understood as a kind of pre-implementation before stepping into a true FMC service.

This leaves the implementation model (B) and its 7 numbering options (B1 – B7) to be further analyzed. Tariff and directory listing issues are not considered in this analysis.

B1. The use of a fixed number only

Pros (+)	Cons (-)
<ul style="list-style-type: none"> ▪ Simple and clear solution with 1 number only 	<ul style="list-style-type: none"> ▪ Use of a fixed number in mobile networks is portability from a fixed to mobile network (NP F↔M)
<ul style="list-style-type: none"> ▪ Only 1 choice for the CLI 	<ul style="list-style-type: none"> ▪ Possible impact on emergency services when a fixed number is used in mobile networks
<ul style="list-style-type: none"> ▪ 	<ul style="list-style-type: none"> ▪ Before NP F↔M the FMC user needs to pay the leg from home-zone to his location
<ul style="list-style-type: none"> ▪ 	<ul style="list-style-type: none"> ▪ Before NP F↔M may cause confusion within parties calling to the FMC user

B2. The use of a mobile number only

Pros (+)	Cons (-)
<ul style="list-style-type: none"> ▪ Simple and clear solution with 1 number only 	<ul style="list-style-type: none"> ▪ Use of a mobile number in fixed networks is portability from a mobile to fixed network
<ul style="list-style-type: none"> ▪ Only 1 choice for the CLI 	<ul style="list-style-type: none"> ▪ Possible impact on emergency services when a mobile number is used in fixed networks
<ul style="list-style-type: none"> ▪ Gives clear indication of the mobility nature of the service 	<ul style="list-style-type: none"> ▪

B3. The use of a new number in a new numbering range

Pros (+)	Cons (-)
<ul style="list-style-type: none"> ▪ Simple and clear solution with 1 number only 	<ul style="list-style-type: none"> ▪ Challenges in introducing and opening a new number range
<ul style="list-style-type: none"> ▪ Only 1 choice for the CLI 	<ul style="list-style-type: none"> ▪ The end user needs to change a number.
<ul style="list-style-type: none"> ▪ 	<ul style="list-style-type: none"> ▪ Possible impact on location determination in emergency services

B4. Combination of a fixed number and a mobile number

Pros (+)	Cons (-)
<ul style="list-style-type: none"> ▪ Existing number ranges 	<ul style="list-style-type: none"> ▪ Choice of the CLI
<ul style="list-style-type: none"> ▪ Clarity when using the fixed number in fixed networks 	<ul style="list-style-type: none"> ▪ Use of a fixed number in mobile networks is portability from a fixed to mobile network
<ul style="list-style-type: none"> ▪ Clarity when using the mobile number in mobile networks 	<ul style="list-style-type: none"> ▪ Possible impact on routing to the nearest emergency centre and location determination

B5. Combination of a fixed number and a number in a new numbering range

Pros (+)	Cons (-)
<ul style="list-style-type: none"> ▪ Clarity when using the fixed number in fixed networks 	<ul style="list-style-type: none"> ▪ Challenges in introducing and opening a new number range
<ul style="list-style-type: none"> ▪ 	<ul style="list-style-type: none"> ▪ The end user needs to change a number with introduction of a new number range
<ul style="list-style-type: none"> ▪ 	<ul style="list-style-type: none"> ▪ Choice of the CLI
<ul style="list-style-type: none"> ▪ 	<ul style="list-style-type: none"> ▪ Use of a fixed number in mobile networks is portability from a fixed to mobile network
<ul style="list-style-type: none"> ▪ 	<ul style="list-style-type: none"> ▪ Possible impact on routing to the nearest emergency centre and location determination

B6. Combination of a mobile number and a number in a new numbering range

Pros (+)	Cons (-)
<ul style="list-style-type: none"> ▪ Clarity when using the mobile number in mobile networks 	<ul style="list-style-type: none"> ▪ Challenges in introducing and opening a new number range
<ul style="list-style-type: none"> ▪ 	<ul style="list-style-type: none"> ▪ The end user needs to change a number with introduction of a new number range
<ul style="list-style-type: none"> ▪ 	<ul style="list-style-type: none"> ▪ Choice of the CLI
<ul style="list-style-type: none"> ▪ 	<ul style="list-style-type: none"> ▪ Possible impact on routing to the nearest emergency centre and location determination

B7. Combination of a fixed number, a mobile number and a number in a new numbering range

Pros (+)	Cons (-)
<ul style="list-style-type: none"> ▪ Clarity when using the mobile number in mobile networks 	<ul style="list-style-type: none"> ▪ Challenges in introducing and opening a new number range
<ul style="list-style-type: none"> ▪ Clarity when using the fixed number in fixed networks 	<ul style="list-style-type: none"> ▪ The end user needs to change a number with introduction of a new number range
<ul style="list-style-type: none"> ▪ 	<ul style="list-style-type: none"> ▪ Choice of the CLI
<ul style="list-style-type: none"> ▪ 	<ul style="list-style-type: none"> ▪ Use of a fixed number in mobile networks is portability from a fixed to mobile network
<ul style="list-style-type: none"> ▪ 	<ul style="list-style-type: none"> ▪ Possible impact on routing to the nearest emergency centre and location determination