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Numbering for Machine-to-Machine Communications

Analysys Mason/Antelope Consulting Report

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1 Executive summary

The Commission for Communications Regulation ('ComReg') discussed numbering for machine-to-machine (M2M) communications with the Numbering Advisory Panel (NAP) and, subsequently, in a Consultation Paper (ComReg 13/33). ComReg commissioned Analysys Mason and Antelope Consulting to consider the responses to an NAP questionnaire and to the Consultation Paper (published as ComReg 13/66). In this report, we present our findings about M2M and mobile numbers after our discussions with stakeholders.

The Consultation Paper describes M2M communication as "[t]he basic building block of the Internet of Things", allowing devices to "communicate directly with one another with minimal or no human intervention".[1] Communications need addresses. For M2M communications, there is a general recognition that IP addresses will be used in the long term, but there is also a widespread expectation that telephone numbers will continue to be used for M2M purposes for several years. The key issue for ComReg is, therefore, whether M2M numbers should be allocated from existing ranges or should adopt new ranges.

We recommend, in the first instance, that ComReg should continue to allocate M2M numbers from the *existing* mobile number ranges until projections demonstrate that shortages will occur. The situation regarding possible shortages should be kept under regular review, and ComReg and the CSPs should introduce number conservation techniques to avoid such shortages.

This is Option 1 (summarised in the following text and dealt with in more detail in Section 5.2). Adopting Option 1 does not prevent ComReg from implementing Options 2 and 3, which involve *new* number ranges, if projections demonstrate that shortages amounting to up to 20 million numbers (Option 2) and more than 20 million numbers (Option 3) will occur and can be avoided by doing so.

We start in Section 3 by explaining the role of telephone numbers in M2M communications and distinguish between M2M and other telephone numbers

As already noted, M2M communications have historically used telephone numbers (via dial-up or SMS), and although services are likely to migrate to broadband, and therefore IP addresses, ComReg must still ensure the effective management and use of numbers, for M2M, just as it does for other communications.

No number ranges in Ireland are currently dedicated to M2M numbers. Instead, M2M numbers have been allocated from the existing ranges (esp. mobile number ranges). There are concerns associated with continuing this, including the risk of exhausting ranges; differences in length between M2M numbers and other numbers; potential differences in regulation; and difficulties in billing and provisioning customers (the process of providing customers with accounts). Our analysis suggests these arguments are less compelling than previously thought.

[1] See http://www.comreg.ie/_fileupload/publications/ComReg1333.pdf.

Section 4 assesses the supply of telephone numbers, outlines future demand, and explains current utilisation of numbers

In practice, at the current rate of allocation, person-to-person (P2P) communications alone could exhaust the supply of seven-digit subscriber numbers available for mobile services. Numbers need to be conserved to prevent rapid depletion. Adding demand for M2M numbers only worsens this situation. One estimate points to a need for 26 million M2M numbers by 2026, which is high, but not implausibly so. The existing mobile number ranges could supply enough for M2M and P2P mobile communications, if numbers were conserved and extraterritorial requirements were limited.[2]

The three options (and their variants) for providing the required telephone numbers are outlined in Section 5

The demand for M2M numbers is as yet unclear. It could almost certainly be met by introducing long subscriber numbers. If doing so had no cost then that would be the obvious thing to do. In the absence of clarity about demand and cost, the strategy for providing M2M numbers is based on options for number ranges and lengths appropriate to different scenarios. These allow for varying degrees of success in number conservation and varying levels of demand.

Option 1 involves using current practice but with number conservation; Option 2 requires a new number range containing normal numbers (seven digits); and Option 3 requires a new number range with the possibility of eight, nine or ten-digit numbers (making 10 billion numbers available at a cost of less than EUR25 million). The proposed strategy, outlined earlier in this summary, permits the introduction of new number ranges and longer numbers for M2M communications to be delayed until the need is more apparent and the cost is more confined (i.e. Option 1 can be adopted initially, but does not exclude the introduction of Options 2 and 3 at a later date).

Section 6 outlines the proposed techniques for conserving numbers (necessary for Option 1)

The techniques for conserving numbers are likely to cost society very little in real terms, and although the quantities of numbers made available are comparatively small (fewer than five million), when accompanied by attitudes that favour conservation, they could be enough to ensure that no extra numbers would be needed for the foreseeable future. The techniques are

1. setting effective utilisation targets
2. reducing the sizes of blocks in allocations
3. charging for numbers
4. shortening the interval between assignments
5. retrieving unused numbers.

Techniques 1, 2 and 3 largely entail actions by ComReg that might encourage CSPs to conserve numbers; Techniques 4 and 5 largely entail actions by communication service providers in response to that encouragement.

[2] For example, there are already instances in the EU where a company building equipment in one country includes in its equipment SIM cards with numbers from another country for distribution throughout the EU.

Section 7 looks at the impact of distinguishing between different types of number (fixed, mobile and premium rate)

If different initial digits of the numbers in a range were used to identify different kinds of M2M communications, the range would become fragmented and the opportunities for using numbers efficiently would be reduced. Confining some M2M numbers for fixed services seems to have little value, because distinctions between such numbers and other numbers would not help CSPs, M2M service providers or customers. Forcing some M2M numbers to be intended for premium-rate services also seems to have little value, because existing regulations appear to be adequate, and it could cause confusion among consumers.

Section 8 introduces the regulatory differences between M2M and other communications

We assess the impact of the differences between M2M and P2P communications on regulation in the areas of number portability, emergency calls, and privacy and security. Our analysis suggests that the differences between the two types of communication are slight in regulatory terms, and that:

- M2M service providers should be able to port M2M numbers assigned to them (and their customers should be able to port numbers if they hold the contracts for the underlying communications services)
- customers should be made aware of which machines are capable of making emergency calls, and any machines making such calls should indicate this to emergency operators through signalling
- customers have a right to be protected from nuisance calls wrongly made to, or received from, machines, with M2M service providers needing to take due care to prevent such mischief.

2 Introduction

The Commission for Communications Regulation ('ComReg') discussed numbering for machine-to-machine (M2M) communications with the Numbering Advisory Panel (NAP) and, subsequently, in a Consultation Paper (ComReg 13/33). ComReg commissioned Analysys Mason Ltd ('Analysys Mason') and Antelope Consulting International LLP ('Antelope Consulting') to consider the responses to a NAP questionnaire and to the Consultation Paper (published as ComReg 13/66). In this report, we present our findings about M2M and mobile numbers after our discussions with stakeholders.

Specifically, ComReg requested that we:

- evaluate the Consultation Paper and the responses to it;
- consider the issues raised by respondents about M2M number length;
- liaise with and determine the views of a sample of industry stakeholders, and
- consider the options available to ComReg and the project costs to implement the options.

In the remainder of this report we therefore:

- review the role of telephone numbers in M2M communications, as background to the responses to the NAP questionnaire and to the Consultation Paper (in Section 3)
- examine number supply and demand, bearing in mind the close relation between M2M services and other services, especially mobile services (in Section 4)
- discuss options for providing numbers when there are concerns about number length, project cost and demand levels (in Section 5)
- discuss techniques for conserving numbers that must be put into effect if the options are to be kept open (in Section 6)
- consider the differences among M2M services that might give rise to numbering distinctions (in Section 7)
- consider the aspects of M2M services that might give rise to regulatory requirements (in Section 8)
- summarise the conclusions and recommendations presented in the earlier sections (in Section 9).

3 The role of telephone numbers

In this section we:

- outline the use of telephone numbers in M2M communications
- distinguish between M2M numbers and other telephone numbers.

3.1 Using telephone numbers in machine-to-machine communications

The Consultation Paper describes M2M communications as "[t]he basic building block of the Internet of Things", allowing devices to "communicate directly with one another with minimal or no human intervention".[3] Communications need addresses. For M2M communications, there is a general recognition that IP addresses will be used in the long term, but there is also a widespread expectation that telephone numbers will continue to be used for M2M purposes for several years. The telephone numbers will often be E.164 numbers (instead of private network numbers), because then M2M service providers can more readily access their machines from public networks, take services from several communications service providers (CSPs) and change their CSPs.

In the past, M2M communications have used dial-up access or the Short Messaging Service (SMS) on fixed or mobile networks, so they have used telephone numbers. Future M2M communications on fixed networks are likely to use 'always on' access and IP addresses; telephone numbers should be irrelevant. Future M2M communications on mobile networks might also use 'always on' access and IP addresses, but if they require 2G or 3G protocols then they will require telephone numbers.

A vigorous move to the use of IP addresses could ultimately reduce to insignificance the demand for numbers for M2M communications.[4] Until that happens, it is our understanding that ComReg has a statutory objective under the relevant act (number 20 of 2002) to encourage the efficient use and ensure the effective management of numbering resources, for M2M communications, just as it does for other communications. Ensuring the effective management of numbers arguably involves both providing numbers to meet demand in competitive markets and conserving numbers to meet as yet unforeseen demand and avoid unnecessary costs or delays in the provision of numbers.

Wireless access is attractive for M2M communications, because of its ease of deployment and (in some cases) mobility. However, the machines accessed in this way might be low-power short-range devices which connect by wireless to a hub; in that case any telephone number used is likely to be associated with the hub, not with those devices, and the hub will be accessed from the operations centre of the M2M service provider over a fixed or mobile network (probably with

[3] See http://www.comreg.ie/_fileupload/publications/ComReg1333.pdf.

[4] Such a move would require the adoption of IPv6 or the introduction of IPv4 Network Address Translation (NAT) equipment capable of handling M2M protocols that have yet to be defined fully, as well as the very widespread use of fixed networks or 4G protocols.

licensed spectrum, because of the convenience of exploiting existing infrastructure and the need to avoid interference). A fixed network might use long range point-to-point radio, perhaps with a medium-range mesh, supporting IP communications. A mobile network might use 2G or 3G protocols. The implications of this on the demand for M2M numbers are considered in Section 4.2.

3.2 Distinguishing machine-to-machine numbers from other telephone numbers

No number ranges in Ireland are currently dedicated to M2M numbers. Instead, M2M numbers have been allocated from the existing ranges (especially the mobile number ranges). The following arguments for allocating M2M numbers from *new* ranges deserve examination. However, our analysis would suggest that the arguments for allocating M2M numbers from new ranges instead of existing ones are less compelling than might be expected, unless the numbers must be longer than other numbers to make enough of them available.

- **Risks of exhausting ranges**. The existing ranges might be exhausted by allocating M2M numbers from them. Evidence about this (in the case of mobile number ranges) is summarised in Section 4.2; it implies that numbers need to be conserved to avoid exhausting the existing ranges, even if they do not continue to be used for M2M services. Of course, using new ranges would exhaust the existing ranges more slowly than using existing ranges solely, but it would also reduce the stock of vacant ranges available for other, as yet unforeseen, purposes.

- **Limitations on access from abroad**. The existing ranges for shared-cost and premium-rate numbers are not accessible from abroad, due to clashes with Dublin numbers, so they are not ideal for M2M services. Also, the existing ranges for non-geographic numbers have not always been accessible from abroad, because some CSPs abroad have been reluctant to route calls to the numbers. Of course, those CSPs might be equally reluctant to route calls to M2M numbers in new ranges. There could be problems in ensuring that none of the CSPs blocked calls for services that required international access, such as vehicle tracking.

- **Differences in length between M2M numbers and other numbers**. A machine does not have the same difficulties as a person in recognising, remembering and dialling telephone numbers, so M2M numbers could be longer than numbers for person-to-person (P2P) communications. If a significant amount of M2M numbers are needed, then they should be longer than other numbers; though they could be accommodated in a sub-range of an existing range, accommodating them in a new range would be more likely to ensure that all ranges were configured correctly, with minimal post-dialling delay. With regards to their lengths, numbers for person-to-machine (P2M) calls (such as those for extracting goods from vending machines or hearing messages from mobile voicemail boxes) are often most like those for P2P calls, unless they are mainly encoded in Quick Response (QR) codes or only kept in telephone address books. By contrast, numbers for machine-to-person (M2P) calls (such as those from alarms to householders to warn of intrusions) are often most like those for M2M calls. Nonetheless no general rule is certain to hold: whether P2M numbers and M2P numbers are like M2M numbers or P2P numbers could depend on the service being offered.

- **Differences in regulation between M2M communications and other communications**. National regulatory authorities tend to use number ranges to demarcate differences in regulation. This is appropriate for P2P communications, as it helps callers to anticipate differences in price, quality and other characteristics. It is not obviously appropriate for M2M communications: the contract holders might be interested in these characteristics, but the machines are not. Moreover, the mobile number ranges in Ireland are partly assigned to M2M service providers already, so any differences in regulation will pervade the mobile number ranges anyway.[5] Introducing differences in regulation between M2M number ranges and mobile number ranges would entail determining which P2M and M2P services ought to be treated like M2M services. Demarcations between services are considered in Section 7 and, from a different perspective, in Section 8.1, where the discussions suggest that differences in regulation would not be simplified by using different number ranges.

- **Possibilities of misdialling or misconfiguring numbers**. Misdialling or misconfiguring numbers might be more likely to happen, and have more serious consequences, if one number range had multiple uses. However, its likelihood is low: human callers are unlikely to misdial repeatedly, and machines are likely to be configured in batch processes designed to eliminate mistakes, just as subscriber identity module (SIM) cards are now. Having new ranges for M2M numbers might not help significantly enough to make a difference.

- **Difficulties in billing and provisioning customers**. In principle, there might be complications in support systems if one number range had multiple uses; in particular, there might be difficulties in finding large single blocks to assign to M2M service providers if assignments to other customers had fragmented the range. Yet again, such complications are there already, in the multitude of postpaid and prepaid packages available to customers, and do not appear to worry CSPs.

In their responses to the NAP questionnaire, some CSPs felt that allocating M2M numbers from existing ranges might risk exhausting the ranges and limit access from abroad. They had divergent views about whether M2M numbers allocated from new ranges should be longer than other numbers.

The Consultation Paper proposed a new number range for M2M numbers, with subscriber numbers having ten digits (though most current subscriber numbers have seven digits).[6] In doing so it was in line with the European Conference of Postal and Telecommunications Administrations (CEPT) Electronic Communications Committee (ECC) recommendation (11)03 *Numbering and Addressing for Machine-to-Machine (M2M) Communications*.[7] Several other national regulatory authorities in the European Union (EU) have made similar proposals, albeit with very different constraints on the available numbers.

5 The Consultation Paper (ComReg 13/33) did not propose moving M2M services that already use existing mobile number ranges to M2M number ranges. Doing so would be infeasible, without changing the SIM cards.

6 The subscriber number is the part of a phone number after the country code (which is 353 for Ireland) and national destination code (which is 76 for the 076 number range, for example).

7 See http://www.erodocdb.dk/Docs/doc98/official/pdf/Rec1103.pdf.

4 Number supply and demand

In this section we:

- assess the supply of telephone numbers in Ireland;
- outline future demand for telephone numbers; and
- explain current utilisation of allocated telephone numbers.

4.1 Supply

Early M2M systems (for building security, for example), depended on fixed networks and often used the geographic numbers of existing fixed lines. However, now the expectation is that many will depend on mobile networks, especially as applications in vehicles might be more numerous than applications in buildings. Moreover, where they depend on fixed networks, they are likely to use IP addresses, not geographic numbers. Mobile number supply and demand are therefore particularly relevant to M2M communications.

According to the numbering database, at the end of 2012, in the mobile number ranges (083–089) 21 531 000 numbers (39% of those available) had been allocated.[8] Extrapolating linearly from the average (alternatively, maximum) annual demand since 2008 suggests that these ranges would be exhausted after 16 (alternatively, ten) years.[9] However, number conservation techniques such as those listed in Section 6.1 could extend the lifetime of these ranges considerably.

Other number ranges (070, 080 and 082) are largely empty and could become available for mobile services. The 072, 073, 075, 077, 078 and 079 number ranges, too, could be pressed into service, as they do not have defined purposes. There should be caution in doing this, as it might accelerate the depletion of the number supply, which is already quite rapid.

4.2 Future demand

The Central Statistics Office forecasted that by 2026 the population of Ireland would be between 5.9 million and 6.0 million.[10] Scaling the quantity already allocated by the maximum projected growth in the population suggests that 24 million mobile numbers could be needed by 2026.[11]

8 This assumes that the initial digit ‘8’ or ‘9’ (depending on the mobile number range considered) of subscriber numbers is reserved to allow for expansion, the initial digit ‘5’ of subscriber numbers is reserved to prevent confusion with voicemail numbers, and the initial digit ‘0’ of subscriber numbers in the 085 range is reserved to provide a future alternative to current shared cost numbers. Consequently 55 million numbers have been, or could be, allocated from the mobile number ranges, including the 084 and 088 ranges (from which no numbers have been allocated so far).

9 Extrapolating by compound interest would shorten the projected time until exhaustion. The periods are rounded down to integral numbers of years.

10 The projections date from 2008, and produce ranges resulting from different assumptions about fertility and migration.

11 In 2011, when the population was 4 588 252, 18 331 000 mobile numbers had been allocated.

However, the recent annual demands used in Section 4.1 point to even higher figures: extrapolating linearly from the average (alternatively, maximum) annual demand since 2008 suggests that 46 million (alternatively, 60 million) mobile numbers would be allocated by 2020, and 67 million (alternatively, 92 million) mobile numbers would be allocated by 2026.

These estimates indicate that P2P communications alone could easily exhaust the supply of seven-digit subscriber numbers available for mobile services. They assume that M2M communications are not taken into account and that numbers are not conserved. In reality these assumptions must be rejected: M2M communications must be taken into account and numbers must be conserved.

The Consultation Paper cited forecasts by Machina Research that by 2020 there would be 25 million M2M connections in Ireland and perhaps 7.5 million of these would not be short-range connections; these 7.5 million connections would include 6.0 million connections to cellular networks where telephone numbers would be needed. These figures relate to connections in use and therefore to numbers in use; the overall quantity of numbers needed would be larger. They also exclude connections which have personal computers (perhaps with dongles) as one or other of the end points; here, these would be regarded as having human operators and therefore as being P2M, M2P or P2P connections.

The predominant M2M systems are for households and vehicles. Yet by 2020 some households and vehicles will still not be equipped with all the main M2M systems, so demand for telephone numbers could continue to grow. Thus, demand could conceivably be bigger than in the forecasts in the Consultation Paper, until about 2026, when systems brought into service earlier would be likely to be replaced progressively by ones using IP addresses. For instance, if every household had three separate hubs (for security alarms, fire alarms and smart meters), and every vehicle had three separate hubs (for emergency calls, vehicle monitors for maintenance, and driving monitors for insurance), and if enterprises were considered in the same way as households, 13 million telephone numbers could be needed for M2M communications.[12]

There are various grounds for uncertainty, in particular, those outlined below.

- Many household M2M systems might use fixed wireless communications or power-line communications, rather than mobile networks. They would not need telephone numbers. In particular, smart meters, which represent the only certain source of large M2M demand in households, might not need telephone numbers.

- Some vehicle M2M systems from car manufacturers and insurers already connect to the mobile telephones of the drivers and use the numbers of those telephones. They could be enhanced with smartphone applications that go well beyond what vehicle components could be expected to do, so they could become very popular. They do not need their own telephone numbers. In fact eCall (which is an EU project to ensure that emergency calls can be made

12 In 2011, there were 1 649 408 households, 189 055 enterprises and about 2.5 million taxed vehicles in Ireland. Each hub is assumed to require a phone number.

automatically after accidents) is the only potential source of large M2M demand in vehicles that is likely to need its own telephone numbers.[13]

- Though smart meters and eCall are under development, other M2M systems are not yet coming to the fore. There are indications that some will not develop as rapidly as once predicted. For instance, Telefónica O2 in the United Kingdom (UK) made available a health event notification service to healthcare providers in March 2012 and to retail customers in March 2013 and announced a health condition monitoring service in March 2013, only to announce the withdrawal of both services in July 2013 because uptake was too low. It had estimated earlier that in the UK, 3 million people would benefit from a personal response service and 15 million people had long-term health conditions.

- The Results of the Multi-Band Spectrum Auction (ComReg 12/123) required that within three years, all licence holders would extend coverage to 70% of the population, with 35% of the population served by the 800 MHz, 900 MHz or 1800 MHz frequency bands. If pricing and coverage let LTE provide many of the M2M connections without needing telephone numbers, the demand for M2M numbers would be lower than otherwise expected. M2M service providers could use devices compatible with LTE even now, though the need to be able to drop back to 2G or 3G protocols in locations not served by LTE would point to continued requirements for telephone numbers.

- There are already instances in the EU where a company building equipment in one country includes in its equipment SIM cards with numbers from another country for distribution throughout the EU. If M2M numbers from Ireland become easily available, they might be used in this extraterritorial way. In the extreme case where almost all M2M numbers in the EU come from Ireland, 1 billion telephone numbers could be needed.[14] There is no evident economic advantage to Ireland in this (especially when the CSPs involved would need international operations or partnerships).[15] It would require the introduction of ten-digit subscriber numbers; unless those numbers are introduced, the extraterritorial requirements for M2M numbers from Ireland must be assumed to be limited.

Though other large contributors to demand could emerge, the figure of 13 million is more likely to overestimate the quantity of numbers in use in 2026 in Ireland than to underestimate it. For instance, each household or vehicle might have only one hub, and need one telephone number, instead of three.

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13 Moreover, whether the numbers should be international or national (and, in the latter case, whether they should come from the country of manufacture or the country of sale) is still open to debate.

14 This scales the figure of 13 million by the approximate ratio of the gross domestic product (GDP) of the EU to the GDP of Ireland.

15 One international CSP is said to be offering numbers from Malta, because of some particularly attractive roaming tariffs. However, the differences in roaming tariffs will fall, as the rates themselves fall. An M2M service provider might be expected to prefer to use numbers from its major market, if it did not use numbers from an international range controlled by the International Telecommunication Union (ITU).

Even when leaving aside the extraterritorial requirements, the demand for M2M numbers must take into account the fact that not every M2M number can be in use. For instance, if the M2M numbers in use were half of those allocated, there could need to be 26 million M2M numbers in 2026, and this figure would be doubled if the proportion of allocated numbers in use were not 50%, but 25% (roughly as it is for mobile numbers currently). Thus, to keep demand to 26 million, numbers would need to be conserved, by using techniques such as those listed in Section 6.1.

Overall, the numbering plan at this stage should allow for the possibility that 26 million M2M numbers (more than three times the 7.5 million relevant connections forecast by Machina Research) could be needed by 2026, before taking into account any potential very large extraterritorial requirements. However, by 2016, more precise estimates should be available, as the full deployment of smart meters will have begun and the M2M functionality available from smartphone applications and commercial eCall modules will be more apparent.

4.3 Current utilisation

At the end of 2012, according to the Quarterly Key Data Report (ComReg 13/25), in Ireland there were 4 905 944 mobile voice subscriptions and 554 563 mobile broadband subscriptions, making a total of **5 460 507**.[16] Each subscription required a telephone number programmed on a SIM card (as would each subscription to an M2M service delivered on a 2G or 3G network). At the same time, in the mobile number ranges (083–089) **21 531 000** numbers had been allocated. Thus the proportion of allocated numbers with active subscriptions, referred to as 'the activity ratio' in this report, was 25%.[17]

Many allocated mobile numbers are in test systems, in quarantine, or in the distribution chain. The same could be true of M2M numbers. For reasons outlined in Section 6.5, the proportions of allocated numbers in quarantine (or inactive before quarantine) for M2M numbers might not be the same as those for current mobile numbers. Having SIM cards inserted into equipment during manufacture would facilitate control and monitoring of the distribution of M2M numbers; indeed, with manufacturing on demand, M2M numbers would not need to be distributed until the equipment was sold. In these respects there are grounds for supposing that the activity ratio could be raised; a figure of 35% is suggested in Section 6.2.

16 Though counterparts to these 2012 figures are available for the first quarter of 2013, the 2012 figures are used in this report to make baselines consistent.

17 A postpaid subscription is active until the contract ceases; a prepaid subscription is active until 90 days have passed since the last chargeable event.

5 Options for providing numbers

In this section we outline the three options (and their variants) for providing the required telephone numbers:

- using existing number ranges
- using new number ranges with subscriber numbers having seven digits
- using new number ranges with subscriber numbers having at least eight digits.

5.1 Summary

The demand for M2M numbers is, as yet, unclear. It could almost certainly be met by introducing long subscriber numbers. If doing so had no cost then that would be the obvious thing to do. In the absence of clarity about demand and cost, the strategy for providing M2M numbers is constructed from options for number ranges and number lengths appropriate to different scenarios. These allow for varying degrees of success in number conservation and varying levels of demand. If number conservation techniques such as those listed in Section 6.1 were effective, then at least 20 million M2M numbers could occupy the mobile number ranges. If the mobile number ranges were ultimately insufficient then there would need to be particular M2M number ranges; the subscriber numbers in those ranges might have seven digits or ten digits, depending on how many of them are needed.

In Sections 5.2 to 5.4 we draw conclusions and make recommendations about various options for providing numbers, as summarised below.

- **Option 1: using existing number ranges**. This can supply enough M2M and mobile numbers if the demand for them from CSPs does not continue to expand ahead of use by customers and there are no very large extraterritorial requirements for M2M numbers. It has the lowest cost among the options. However, unless numbers are conserved, the existing number ranges will ultimately be inadequate.

- **Option 2: using new number ranges with subscriber numbers having seven digits**. This can be adopted if the demand for M2M numbers seems likely to make the existing number ranges inadequate for M2M and mobile numbers together. Adoption would take, at most, two years and would have a low cost.

- **Option 3: using new number ranges with subscriber numbers having at least eight digits**. This can be adopted if the demand for M2M numbers seems likely to grow well in excess of current projections, perhaps because of very large extraterritorial requirements for M2M numbers. It requires modifications to support systems that would take some time and have some cost if they were implemented before the systems were due for upgrades.

The options are tabulated in Figure 5.1 (in which the lengths of new subscriber numbers appear in brackets alongside the options). The indicative costs to society as a whole are categorised as: up to EUR1 million ('very small'); greater than EUR1 million, but less than EUR5 million ('small'); EUR5 million or greater, but less than EUR25 million ('moderate'); EUR25 million or greater, but less than EUR125 million ('large'); or, at least EUR125 million ('very large'). The costs can be very small if the CSPs do not need to make various system upgrades. The implications of the options (in brackets after the summaries of the options), together with the costs, determine the options chosen for the strategy.

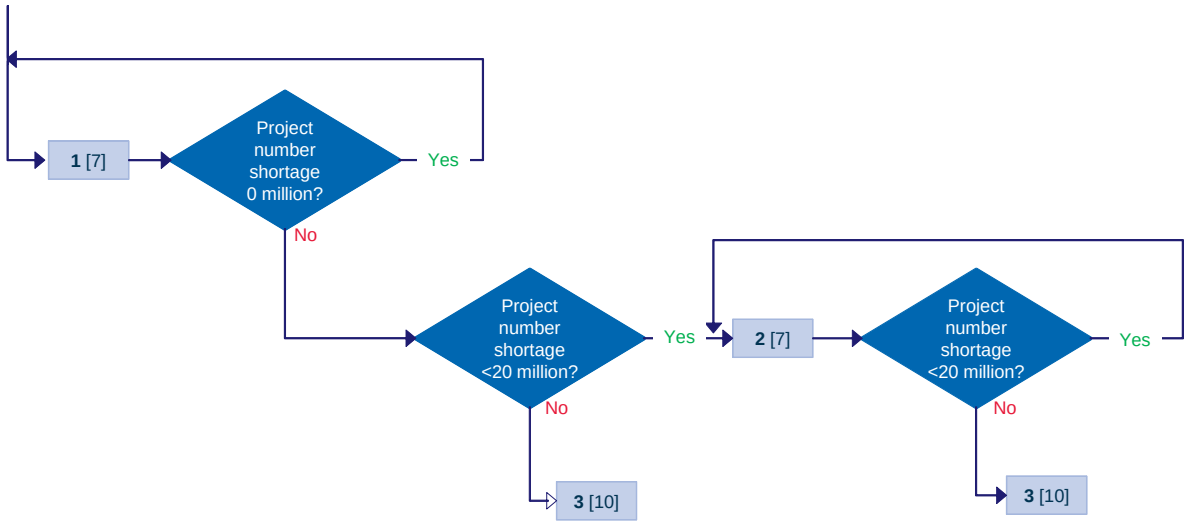
Figure 5.1: Options relevant to different number requirements [Source: Antelope Consulting]

Option [with subscriber number length]	Quantity of extra numbers made available	Cost	Summary [with implications]
1 [7 digits]	0	Very small	Continuing mainly with current practice [need for mobile number conservation, need for M2M number conservation, possible misdialling of numbers, possible misconfiguration of numbers]
2 [7 digits]	20 million	Very small	Having a new range containing normal numbers [need for mobile number conservation, need for M2M number conservation]
3 [8 digits]	100 million	Moderate	Having a new range containing long numbers [long P2M numbers, need for mobile number conservation]
3 [9 digits]	1 billion	Moderate	Having a new range containing long numbers [long P2M numbers, need for mobile number conservation]
3 [10 digits]	10 billion	Moderate	Having a new range containing long numbers [long P2M numbers, need for mobile number conservation]

The proposed strategy permits the introduction of new number ranges and longer numbers for M2M communications to be delayed until the need is more apparent and the cost is more confined. We assume that Option 1 is adopted initially, but in Sections 5.2 to 5.4 we make recommendations about actions related to Options 1, 2 and 3 that should be taken alongside Option 1. If number shortages arise despite the actions related to Option 1, or if the other reasons for allocating M2M numbers from new ranges discussed in Section 3.2 are more significant than they currently appear, one or both of Options 2 and 3 can be adopted.

The choice of options is made according to projections about number shortages that become firmer as the monitoring of allocations and trends proceeds in the way illustrated in Figure 5.2. In this, the 'best' option is chosen that will fit the projected demand, but, in the course of allocating the numbers made available by that option, the demand is monitored so that a further option can be chosen if the demand becomes likely to exceed the supply from the 'best' option.

Figure 5.2: Options chosen in the light of projected number shortages [Source: Antelope Consulting]



5.2 Option 1: using existing number ranges

According to the figures in Section 4.2, with no decrease in the activity ratio for mobile numbers below the 25% level noted in Section 4.3, 24 million numbers would be enough for P2P communications. Also, with M2M numbers used much more efficiently than mobile numbers have been, 26 million numbers would suffice for M2M communications. The existing mobile number ranges (083–089), with the current reservations, can make 55 million numbers available. They can therefore supply enough numbers for both M2M and P2P communications, if numbers are used efficiently and extraterritorial requirements are limited.

There are various arguments for allocating M2M numbers from new ranges. However, as discussed in Section 3.2, current information about configuration and provisioning practices suggests that these arguments are not as strong as might be expected.

Continuing to allocate M2M numbers from the existing mobile number ranges has very low costs in the short term, but not necessarily in the long term if shortages occur. Number conservation techniques such as those listed in Section 6.1 can reduce the risk of shortages, without themselves having high costs. Whether the shortages are likely to occur can best be judged when there is more evidence about the quantity and nature of M2M communications and the effectiveness of number conservation techniques. In the short term, the option of allocating M2M numbers from the existing mobile number ranges, while implementing number conservation techniques rigorously, seems satisfactory.

The rate of allocation must be monitored to ascertain whether M2M numbers should continue to be allocated from the existing ranges. Such monitoring can use the information submitted in applications for numbers according to the Numbering Application Procedures (ComReg 11/18), where the purpose of an allocation should distinguish between M2M, P2P, P2M and M2P communications, and should not include both M2M and P2P communications. Unallocated

numbers would not be forced to be intended for M2M communications or forced to be intended for P2P communications, so the ranges would not be fragmented unnecessarily.[18]

Any M2M services carrying IP data that were inappropriate for the mobile number ranges (for reasons mentioned in Section 7.1) could be allocated numbers in the IP-based number range (076). Again, the purposes of allocations should be stated in the applications.

Figure 5.3: Option 1: using existing number ranges [Source: Antelope Consulting]

Attribute	Assessment	Explanation
Extra numbers provided	0	
Costs to service providers	Small	
Costs to residential customers	Small	Recognising any M2M numbers encountered
Costs to business customers	Small	
Other objections by the public	Small	
Risks	Moderate	Need for mobile number conservation, need for M2M number conservation, possible misdialling of numbers, possible misconfiguration of numbers

We recommend that:

- ComReg should usually allocate M2M numbers from the existing mobile number ranges until projections demonstrate that shortages will occur
- ComReg should, at intervals of two years, review whether such shortages might occur within the following four years
- ComReg and the CSPs should introduce number conservation techniques, with the objective of ensuring that such shortages do not occur
- ComReg should, exceptionally, allocate M2M numbers from the IP-based number range if the existing mobile number ranges are inappropriate because of requirements in the National Numbering Conventions
- ComReg should require applications for future allocations to distinguish between M2M, P2P, P2M and M2P communications and to avoid including a mix of both M2M and P2P communications as purposes for allocated numbers
- the CSPs should notify ComReg about changes in the purposes for which allocated numbers are used.

A variant of this option involves introducing subscriber numbers with eight digits: subscriber numbers (in the existing mobile number ranges) beginning with 8 or with 9, depending on the range, would be reserved until they were allocated, when they would have eight digits instead of seven. The supply of numbers in the ranges would thereby be almost doubled. However, as

[18] However, there would be merit in making allocations adjacent to one another if they have the same size, as allocations having a larger size would then be easier to fit in. For instance, allocating ten adjacent blocks having 10 000 numbers each starting at 00x 0000, permits the allocation of one block having 100 000 numbers starting at 010 0000, while allocating ten separated blocks having 10 000 numbers, each starting at 0x0 0000, does not permit this.

respondents to the Consultation Paper remarked, letting subscriber numbers in one range have different lengths could result in misconfiguration (in national or international networks) and unnecessary lengthening of the post-dialling delay.[19] Moreover, there could be a significant extra cost in making eight-digit numbers available for M2M services, for reasons outlined in Section 5.4.

5.3 Option 2: using new number ranges with subscriber numbers having seven digits

To safeguard against underestimates of demand, new number ranges could be used for M2M communications. Initially one range, with seven-digit subscriber numbers, could be introduced; if that range neared exhaustion, a further range could be introduced to provide more such numbers (unless the move towards exhaustion was more rapid then than had been projected initially, in which case the subscriber numbers might have ten digits). Introducing new ranges such as these might be more satisfactory than using existing ranges for the reasons discussed in Section 3.2. However, it would deplete the stock of vacant ranges in order to satisfy a demand that the existing ranges might possibly have satisfied.

There are 54 million seven-digit subscriber numbers available in the 072, 073, 075, 077, 078 and 079 number ranges.[20] If one of these number ranges were to be used for M2M communications, 072 would be an obvious possibility. It would allow for future encroachment of M2M numbers into an adjoining range (with subscriber numbers having a different length, if necessary).[21] Of course, 077 would also allow such encroachment, but its repetition of 7 is a feature that might be appreciated in P2P communications, but would be wasted in M2M communications.

According to a respondent to the Consultation Paper, adding a new CSP to an existing mobile number range (089) costs the industry more than EUR1 million. It would involve development and testing to let the range have different sub-range holders, potentially with blocks of 100 000 numbers each. Any development would entail at least comparable testing (which cost EUR150 000 per mobile network, in the opinion of one respondent); allowing for consultation and delivery schedules, it might take two years once the need for it was clear. Opening a new number range, such as 072, without any development, would presumably also entail testing.

In the short term, new number ranges do not seem to be required to ensure that there are enough numbers (though they might be desirable in order to make M2M numbers distinguishable from mobile numbers). If they are introduced, there should be, at most, two of them, using only seven-digit subscriber numbers, to limit the depletion of the stock of vacant ranges. If demand were projected to exceed the supply from two such ranges, then subscriber numbers with more than

19 Though voicemail subscriber numbers have eight digits, they always begin with '5', so the post-dialling delay for mobile numbers can be independent of the number lengths.

20 This assumes that an initial digit of subscriber numbers is reserved to allow for expansion. However, this digit is not reserved in the option discussed here; indeed, its use for lengthening existing numbers (as opposed to providing new longer numbers) might not be feasible in the short term without changing SIM cards.

21 It would also avoid any overlap with currently allocated number ranges in the UK that might otherwise be misinterpreted in border areas.

seven digits would be preferable, on the assumption that by then the network and support systems could accommodate them.

Figure 5.4: Option 2: using new number ranges with subscriber numbers having seven digits [Source: Antelope Consulting]

Attribute	Assessment	Explanation
Extra numbers provided	20 million	(072) xxx xxxx, (073) xxx xxxx, for example
Costs to service providers	Small	
Costs to residential customers	Small	Learning the significance of the number range
Costs to business customers	Small	
Other objections by the public	Small	
Risks	Moderate	Need for mobile number conservation, need for M2M number conservation

We recommend that:

- ComReg should allocate seven-digit subscriber numbers from new M2M number ranges only if projections demonstrate that otherwise shortages amounting to at most 20 million numbers will occur
- ComReg should reserve at least two number ranges among 072, 073, 075, 077, 078 and 079 in case M2M numbers are ultimately allocated from new number ranges.

A variant of this option involves introducing subscriber numbers having eight digits: subscriber numbers (in the new M2M number ranges) beginning with 8 or with 9 would be reserved until they were allocated, when they would have eight digits instead of seven. In effect, this has the same advantages and disadvantages as the variant described in Section 5.2; in particular, it almost doubles the supply of numbers in the range.

5.4 Option 3: using new number ranges with subscriber numbers having at least eight digits

Introducing a new number range entails occupying a currently unoccupied national destination code. This is not done lightly. To minimise its recurrence, the new subscriber numbers could have eight, nine or ten digits. For M2M communications, as opposed to P2P communications, doing this is acceptable, because machines do not find long numbers especially difficult to recognise, remember and dial. Indeed, as the Consultation Paper noted, the CEPT ECC recommended that M2M numbers should be as long as possible. The examples in Section 3.2 suggest that often M2P numbers, but not P2M numbers, would resemble M2M numbers in this respect.

If the only constraint were the overall number length, as defined by E.164, the subscriber numbers for M2M communications could have ten digits. However, there is another potential constraint: the cost of implementation.

Eight-digit subscriber numbers can already be accommodated by the network and support systems in certain respects, because they are needed for the mobile numbers for voicemail.[22] Indeed subscriber numbers having nine or ten digits could be accommodated by at least some of those systems. In general, network systems can accommodate long numbers, as traffic to addresses with long numbers must be able to pass across the networks if international calls are to be made. However, various support systems, especially for provisioning and billing (both mobile and fixed, in some cases), would require modification if national calls were to be made to subscriber numbers with more than seven digits. After the modifications had been made, all the systems into which these ones linked would also need to be tested. One CSP stated that testing simple modifications costs it about EUR150 000.

As with any system developments, the cost of the modifications is likely to be significantly lower if the modifications can be accommodated in existing upgrade programmes; after all, the testing is needed even if the modifications are not made. All other things being equal, the allocation of subscriber numbers with at least eight digits would be delayed until the need was more apparent or the modifications could be made more economically, possibly by bringing forward upgrade programmes.

If the need for long numbers became more apparent, the modifications to systems would be necessary. Bearing in mind the length of development cycles, the relevant consultation, development and testing might take three years, so projections of demand would need to look ahead for at least that length of time (or, more cautiously, four years). In the interim, M2M numbers would be allocated from existing number ranges unless the supply appeared insufficient (when new ranges would be needed).

Figure 5.5: Option 3: using new number ranges with subscriber numbers having at least eight digits [Source: Antelope Consulting]

Attribute	Assessment	Explanation
Extra numbers provided	100 million; 1 billion; 10 billion	(073) xxxx xxxx, for example; (073) xxxxx xxxx, for example; (073) xxxxxx xxxx, for example
Costs to service providers	Large	System upgrades
Costs to residential customers	Small	Learning the significance of the number range
Costs to business customers	Small	
Other objections by the public	Small	Long P2M numbers
Risks	Small	Need for mobile number conservation

22 They do not need to be entered into provisioning systems explicitly, because mobile numbers for voicemail boxes are formed automatically by placing '5' in front of the corresponding seven-digit subscriber numbers.

We recommend that:

- ComReg should allocate ten-digit subscriber numbers from new M2M number ranges only if projections demonstrate that otherwise shortages amounting to at least 20 million numbers will occur in the near future
- the CSPs should include in their upgrade programmes for network and support systems the removal of limitations on the lengths of subscriber numbers, in case M2M or other subscriber numbers are ultimately required to have at least eight digits
- ComReg should, at intervals of two years, review progress towards removing such limitations.

6 Techniques for conserving numbers

In this section we outline the following techniques for conserving telephone numbers:

- setting effective utilisation targets
- reducing the sizes of blocks in allocations
- charging for numbers
- shortening the interval between assignments
- retrieving unused numbers.

6.1 Summary

As indicated in Section 4.2, if the allocation of mobile numbers continued at its present rate, even without the boost due to large quantities of M2M numbers, by 2020 between 46 million and 60 million mobile numbers would be allocated. The existing mobile number ranges (083–089) can provide 55 million numbers, including the numbers already allocated, if the vacant ranges (084 and 088) are brought into service. So, even by 2020, extra mobile number ranges might be needed just for P2P numbers, if the existing numbers are not conserved.

The ranges 070, 080 and 082 could be available. However, 070 might arouse suspicions because of earlier associations with personal numbers, and 080 is favoured internationally for freephone numbers. Other ranges (072, 073, 075, 077, 078 and 079) could be used as well, but they would be unfamiliar to customers and, for preference, would be avoided for P2P communications. Hence, among these ranges only 082 is clearly suited to P2P communications. Without effective number conservation, longer numbers could be needed, though the Irish population would still be below 6.0 million.

In Sections 6.2 to 5.6 we draw conclusions and make recommendations about various techniques for conserving numbers, as summarised below.

- **Technique 1: setting effective utilisation targets**. This is the starting point in avoiding number shortages: ComReg would agree a target to improve efficiency in the use of numbers with the CSPs, each of which would devise its own ways of reaching the target. Modest process changes (if necessary) could raise the activity ratio from the current 25% to 35%, which, with the projected level of use of numbers, could be adequate.

- **Technique 2: reducing the sizes of blocks in allocations**. This could encourage consideration of whether extra numbers were really needed and could cater efficiently for small and experimental providers of M2M and other communications.

- **Technique 3: charging for numbers**. Numbers will be conserved only if the long-term benefits of doing so can be recognised. To offset short-term pressures on the CSPs and achieve an equitable distribution of any costs, charging for numbers might ultimately be appropriate,

though it is not called for yet. It would ensure that CSPs had equivalent incentives to raise the activity ratio.

- **Technique 4: shortening the interval between assignments**. Inevitably there will be many M2M and mobile numbers in quarantine between assignments to different customers.[23] However, efficiency in the use of numbers could be improved by ensuring expeditious entry into, and exit from, quarantine.

- **Technique 5: retrieving unused numbers**. Operating processes ought to pay heed to the circumstances in which assigned numbers are unused and could be retrieved. For instance, any M2M and mobile numbers in the distribution chain that never enter into use should ultimately be made available again. Similarly, the number portability process needs to ensure that ported numbers that are subsequently taken out of use do not disappear, but are made available for re-assignment.

The techniques are tabulated in Figure 6.1. Some illustrative costs to society as a whole are categorised as: up to EUR1 million ('very small'); greater than EUR1 million, but less than EUR5 million ('small'); EUR5 million or greater, but less than EUR25 million ('moderate'); EUR25 million or greater, but less than EUR125 million ('large'); or, at least EUR125 million ('very large'). The estimates suggest that the cost per number made available might be under EUR1. The costs and the quantities of numbers are estimated from hypothetical data (and the quantities of numbers are not estimated for techniques that mainly encourage attitudes that make other techniques more effective). Though the quantities of numbers made available by the techniques are smaller than those made available by options for providing extra numbers, when accompanied by attitudes that favour conservation, they could be enough to ensure that no extra numbers were needed.

Figure 6.1: Techniques relevant to different number requirements [Source: Antelope Consulting]

Technique	Quantity of numbers made available	Cost	Summary
1		Very small	Setting effective utilisation targets
2	0.7 million	Very small	Reducing the sizes of blocks in allocations
3		Moderate	Charging for numbers
4	0.5 million	Very small	Shortening the interval between assignments
5	4.6 million	Small	Retrieving unused numbers

Techniques 1, 2 and 3 largely entail actions by ComReg that might encourage CSPs to conserve

[23] In this report an 'allocation' is a primary allocation unless otherwise stated, and an 'assignment' is an allocation to a user (in the sense of the National Numbering Conventions) that is not for this use a CSP. Thus an M2M service provider is necessarily a user, but not necessarily also a CSP. If E.212 were revised to let an M2M service provider have a mobile network code (MNC), which is not currently the case, ComReg might then assign numbers directly to that M2M service provider.

numbers; Techniques 4 and 5 largely entail actions by CSPs in response to that encouragement. In Sections 6.2 to 6.6 we make recommendations related to all of these techniques.

6.2 Technique 1: setting effective utilisation targets

According to the Numbering Application Procedures (ComReg 11/18), ComReg may require applicants to provide plans justifying allocations. These plans could usefully be accompanied by plans for raising the activity ratio. Certainly, the activity ratio should not fall below the current 25% level if, in doing so, it requires costly enhancements to systems or processes to accommodate new number ranges.

An activity ratio of 35% could conserve numbers adequately. It would take account of current allocations, but might require modest changes to practice among CSPs. It should cover secondary allocations to CSPs as well as primary ones: secondary allocations should not be regarded as being 100% in use just because the numbers have passed into different hands.

We recommend that:

- ComReg, after discussions with the CSPs, should set a target lower bound for the activity ratio for M2M and mobile numbers that is at least 35%
- the CSPs should devise and implement plans for ensuring that this target is reached
- ComReg should perform detailed regular audits of the quantities of numbers in use
- ComReg should check applications for future allocations of M2M and mobile numbers for evidence that the demand could not be met partly or wholly from prior allocations and that the plans for reaching this target are being implemented effectively.

6.3 Technique 2: reducing the sizes of blocks in allocations

In 2010, following an audit of mobile numbers, the NAP agreed that ComReg would review the size of blocks for allocation when the audit was repeated. Reducing the sizes of blocks in allocations from 100 000 numbers to 10 000 numbers would encourage applicants to consider carefully what they really need. However, it would add a small administrative overhead, as extra applications would sometimes be necessary, and it might require modifications to support systems, as deeper digit analysis would be needed to determine the sub-range holders for numbers. As discussed in Section 5.3 (in a different context), such modifications could be accommodated in upgrade programmes. One CSP puts the costs somewhere between EUR50 000 and EUR200 000 per mobile network, depending on the nature of the upgrade.

Between 2005 and 2010 6 900 000 mobile numbers were allocated, in blocks of 100 000 numbers each, meaning applications were made at an average annual rate of 13.8. If decreasing the block size added EUR500 to the cost of an application and applications (potentially for multiple blocks) were made at the same rate for the next ten years, the additional cost over ten years would be EUR69 000. Furthermore, if 5% of the allocated numbers (amounting to 690 000 numbers) could

be saved over ten years by having smaller blocks, the cost per number made available would be EUR0.10.

We recommend that:

- ComReg should set a sub-range holder block size for M2M and mobile numbers that is, at most, 10 000 from a date defined after discussions with the CSPs
- the CSPs should, in their upgrade programmes for network and support systems, include the introduction of this sub-range holder block size.

6.4 Technique 3: charging for numbers

Some CSPs, in effect, charge shops about EUR2 for each provisioned SIM card (and therefore number). They do this to reduce wastage. ComReg could apply the same principle, by charging, say, EUR0.1 per number per year for all allocated M2M and mobile numbers, or perhaps for all such numbers that were not in use (in which case the charge could not be passed on to customers so plausibly).[24] Payment would confer rights of use, not ownership, just as at present.

Charging would have the merit of ensuring that CSPs had equivalent incentives to raise the activity ratio; otherwise some CSPs would have advantages over others if, for historical reasons, they had more numbers allocated, but fewer numbers in use. However, finding the right level of charge would be difficult. We do not recommend that ComReg institutes charging if numbers can be conserved effectively without it.

We recommend that:

- ComReg should, at intervals of two years, review whether there should be charges for M2M and mobile numbers.

6.5 Technique 4: shortening the interval between assignments

Numbers that are no longer in use are placed in quarantine for 13 months before being recycled. Fewer numbers would be needed overall if this period were shortened. However, the quarantine period is founded on the requirement that people do not receive unsolicited calls and messages about services when an 'opt-out' period of 12 months has passed since the previous uses of the services. These calls and messages might come from machines, either deliberately (when a premium-rate service provider sends marketing material, for example) or inadvertently (when an M2M service provider misconfigures a device, for example). Thus, as a general rule, the quarantine period should not be shortened without a corresponding reduction in the opt-out period.

The quarantine period before numbers are re-assigned after use by M2M service providers could be shorter than 13 months, if the M2M service providers were constrained to offer only dial-in

[24] Relating charges to the extent to which service providers fall short of the targets would tend to distort the targets.

services and dial-out services to very particular numbers (such as 112). This constraint would be irksome to satisfy and awkward to enforce. It would be unlikely to reduce greatly the proportion of numbers in quarantine, so at this stage we do not recommend that ComReg considers it further.

For postpaid accounts, numbers can pass directly from being in use to being in quarantine when the contracts are terminated. For prepaid accounts, before entry into quarantine, there is likely to be an inactivity period, typically of between six and nine months for mobile numbers.[25] If CSPs do not make numbers pass automatically from being inactive to being in quarantine, the numbers are not recycled as rapidly as they could be. In 2010, according to the audit results, 10% of the allocated mobile numbers were in quarantine and 64% of the accounts were prepaid, so the proportion of allocated numbers entering quarantine after inactivity was approximately between 6% and 9% annually.[26] Process changes that let these allocated numbers be inactive for only six months instead of nine would be equivalent to making available between 300 000 and 500 000 numbers (approximately).[27]

M2M numbers might be provided for postpaid accounts or for prepaid accounts; for instance, remote monitoring of smart meters might be postpaid, while data access from personal computers might be prepaid. Every service needs to be considered separately in this respect. For instance, eCall could require a long inactivity period, as, unless there are test calls, eCall modules remain inactive until vehicles collide (when the vehicles or their occupants make emergency calls).[28] Overall, the churn on accounts seems likely to be lower for M2M services than for current mobile services, because the equipment is less readily discarded, so the proportion of numbers in quarantine or inactive before quarantine could be lower for M2M services than for current mobile services.

We recommend that:

- ComReg should take advantage of any reduction in the opt-out period to reduce the quarantine period for M2M and mobile numbers
- the CSPs should ensure that numbers pass rapidly to being in quarantine after cessation of service (for postpaid accounts) or at the end of the inactivity period (for prepaid accounts).

25 The inactivity period starts when the subscription is no longer active.

26 Postpaid accounts tend to be kept longer than prepaid accounts, so between 64% and 100% of the numbers in quarantine would be for prepaid accounts and would have been inactive before entry into quarantine, and 12/13 of these would have entered quarantine during the preceding year.

27 The process changes save 3/12 of a "number year" on each occasion that a number enters quarantine after inactivity, and, each year, approximately between 6% and 9% of the 21,531,000 allocated numbers enter quarantine after inactivity, so the process changes save approximately between 300,000 and 500,000 "number years per year", or numbers.

28 Also, eCall modules could be enhanced naturally to make calls to insurers after collisions. In so doing they would violate potential constraints (such as dialling out only to emergency numbers) that could otherwise shorten the quarantine period.

6.6 Technique 5: retrieving unused numbers

Assigned numbers can remain or become out of use, in which circumstance they could be recycled. Some instances are outlined below.

- Before SIM cards are distributed to retail outlets, numbers are often included in them, at least for prepaid accounts. This is convenient in some situations (as, for example, travellers can obtain SIM cards from hotels and hostels), but it can be wasteful. For instance, a CSP might order SIM cards for all the numbers in a block; the numbers might remain unused and be lost, either because some of the SIM cards were not distributed to retail outlets or because prospective customers were offered numbers different from those distributed. For a subsequent promotion the CSP might distribute new SIM cards with special packaging; though it might try to retrieve the old SIM cards by charging retail outlets for the new ones if the old ones were not returned, some might still be lost. In a further promotion, yet more SIM cards might be given away in the streets; the numbers left unused would never become active and would therefore never be re-assigned.

- Some time after the numbers assigned to a customer have been ported, the customer might stop taking services. In this situation, according to the Mobile Number Portability Process Manual, the recipient operator should first pass the number through quarantine and then "repatriate" it back to the sub-range holder, which can re-assign it. However, the Mobile Number Portability Process Manual does not lay down the timescale in which repatriation should occur. Consequently repatriation might never occur. This would make the pool of numbers leak into a sink where neither the recipient operator nor the sub-range holder had effective control of the numbers. CSPs have suggested that it represents the major way in which unused numbers are essentially lost.

Illustrative costs and returns are as follows.

- In 2010, according to the audit results, 13% of the allocated mobile numbers were in the distribution chain.[29] Many of these pass through the distribution chain and become used within one year, but some are lost. The losses could be avoided if, instead, numbers were entered into SIM cards only or mainly at the point of sale or unsold and unused SIM cards were cancelled after some time. If losses of 10% of the allocated mobile numbers in the distribution chain could be avoided by doing this, then over ten years 2 800 000 mobile numbers could be retrieved. The cost for doing this would be confined to any CSPs without appropriate systems and processes already in place; it might amount to EUR5 million, when the cost per number made available would be EUR0.6.

- Until 2009, when the figures stopped being published, about 300 000 mobile numbers were ported annually. If at any time 10% of the allocated numbers are in quarantine for 13 months, then about 9% of the customers annually stop taking a service and after ten years about 61%

[29] In addition, 15% were reserved and 14% were free. The reserved ones might themselves be kept aside pending receipt of a supply of SIM cards ready for distribution.

will have stopped taking a service (because the probability of survival from one year to the next is 91%). These proportions apply to customers who do not port their numbers; if the same proportions apply to customers who port their numbers, after ten years, with 300 000 numbers ported annually, over ten years 1 800 000 mobile numbers could be returned to the original sub-range holders under the number portability process. The cost for this would be very small, as it would be subsumed in that of regular staff training.

We recommend that:

- the CSPs should limit the extent to which M2M and mobile numbers are distributed before assignment to customers
- the CSPs should cancel SIM cards that include numbers and that remain unsold and unused for some time, and re-use the numbers
- the CSPs should make arrangements to ensure that ported M2M and mobile numbers that subsequently stop being assigned to customers are returned after quarantine, automatically and immediately, to the sub-range holders for re-assignment.

7 Numbering distinctions

Most M2M numbers are expected to be needed by mobile services. However, some might be needed by fixed services or by premium-rate services. The Consultation Paper raised the possibility of distinguishing some M2M numbers as being intended for services with particular characteristics, specifically by using separate sub-ranges of an M2M number range for mobile services, fixed services and premium-rate services.

In this section we explore:

- separating fixed services from mobile services
- separating premium-rate services from mobile services.

7.1 Separating fixed services from mobile services

A distinction between M2M numbers for fixed services and M2M numbers for mobile services would impede unnecessarily the introduction of M2M services involving SIM cards embedded at the point of sale in desktop computers, laptop computers, tablets and telephones.[30] It would be especially awkward if the M2M numbers for fixed services were classed as geographic numbers, in which case they would be subject to different number portability requirements and systems. More generally, a distinction between M2M numbers for fixed services and M2M numbers for mobile services would depend on the distinction between fixed services and mobile services, which is becoming blurred: participants in mobile telephone calls often have fixed locations, and geographic numbers sometimes represent fixed end points on cellular networks. Even a distinction based on the presence or absence of hand-over is obscure, when some mobile services provide hand-over between Wi-Fi and cellular networks, but others do not.

Of course, there remains a useful distinction between geographic numbers (as opposed to numbers for fixed services, which could well be supported in anchored versions of mobile equipment) and mobile numbers for P2P communications. That distinction has various purposes: it lets users have expectations about call price, quality and participant location (apart from short-term nomadic operation), and it helps with detailed call routing. Surveys show that users still value the geographic information in numbers.[31] This is borne out by the preference shown by customers in Ireland for switching from IP-based numbers to geographic numbers when those became available to them.

However, these distinctions do not seem important for M2M communications. The extent to which a service supports mobility of the end points should be apparent to customers from the nature of

30 In addition, the classification of the services as M2M services (rather than P2M, M2P or P2P services) would depend on modes of use that might not persist over time.

31 For instance, in the UK the majority of respondents to surveys (64% in 2010 and 56% in 2005) thought that telling the location from the number was important.

the service, not the choice of number range. An M2M number range that did not incorporate the entire geographic numbering structure would be unlikely to help with detailed call routing.[32]

The current National Numbering Conventions (ComReg 11/17) state that mobile numbers should be used "to identify mobile termination points" and may be used "to provide services, with certain exceptions" (though they do not define "mobile"). There might, therefore, be a reason why some M2M numbers should not be mobile numbers. Most likely, though, those numbers would be for services carrying IP data; as such, they could come from the IP-based number range, as proposed in Section 5.2.

In summary, forcing some M2M numbers to be intended for fixed services seems to have little value, because distinctions between such numbers and other numbers would not help CSPs, M2M service providers or customers. Also, it could impede innovation, as M2M service providers would be obliged to treat fixed equipment differently from mobile equipment. Moreover, separating out part of a number range in this way would fragment the range and thereby reduce the opportunities for using numbers efficiently.

We recommend that:

- ComReg should not single out a class of M2M numbers for fixed services, but should note the relevance of the IP-based number range if not all M2M services can be regarded as mobile services for the purposes of number allocation.

7.2 Separating premium-rate services from mobile services

There might be premium-rate charges for some M2M communications; for instance, M2M or M2P systems for building security could dial premium-rate numbers to report intrusions. Moreover P2M systems for vending machines might have premium-rate numbers that potential customers would dial to extract goods. Introducing another range of numbers for such systems, besides the existing premium-rate number ranges, would be confusing.

Premium rate regulations exist to protect consumers from unexpected high charges for goods, services or content on their telephone bills. The Premium Rate Code of Practice (ComReg 12/29), along with the relevant act (number 2 of 2010) and statutory instrument (number 111 of 2012) already lays down conditions on subscription services and reversed-charging services that appear to be independent of the telephone numbers from which the content is sent; the premium-rate numbers are usually those dialled to purchase the services. Such services typically comprise M2P communications, but they could comprise M2M communications; for instance, an archive could receive regular updates. Often, however, M2M services will be subscription services set up without any reference to premium-rate services, because the charges will not be items on telephone bills.

[32] The Consultation Paper (ComReg 13/33) did not propose incorporating the entire geographic numbering structure in the M2M number range. Doing so would complicate any potential number changes.

By contrast with existing premium-rate numbers, M2M numbers would be internationally accessible, when the interconnection and billing arrangements had been established. However, ensuring some M2M numbers were intended for premium-rate services would complicate those arrangements. It would also be liable to confuse users, as premium-rate service providers might introduce M2M, P2M or M2P variants of their services to ensure international access. The merit of international access to premium-rate numbers is dubious enough without this confusion.

In summary, forcing some M2M numbers to be intended for premium-rate services seems to have little value, because existing regulations appear to be adequate. Also, it could cause confusion, as such numbers and existing premium-rate numbers would not have clearly different purposes. Moreover, separating out part of a number range in this way would fragment the range and thereby reduce the opportunities for using numbers efficiently.

We recommend that:

- ComReg should not single out a class of M2M numbers for premium-rate services, but should monitor how M2M numbers are used in conjunction with premium-rate services.

8 Regulatory requirements

In this section we:

- introduce the regulatory differences between M2M and other communications
- look at these differences in relation to their impact on regulation in the areas of number portability, emergency calls, and privacy and security.

8.1 Introduction to the regulatory differences

The regulatory differences between M2M communications and P2P communications are slight: almost all regulatory requirements that are relevant to one are relevant to the other. The main exceptions relate to emergency calls: as discussed in Section 8.3, perhaps not all M2M end points are expected to make, and pass location information in emergency calls. Another potential exception relates to calling line identity (CLI): there might be no need to be able to restrict CLI presentation in M2M communications.[33]

Of course, eCall does require the ability to make emergency calls. However, an eCall call can be made by a person or a machine and is received by a person (who controls an in-band modem for data transmission and reception), that is to say, it can be a P2P communication or an M2P communication. In fact eCall has the following important attributes:

- it is subject to particular service-specific rules
- it blurs the boundary between M2M communications and P2P communications
- it is unlikely to be the only service taking numbers from a particular number range.

Other services have some of these attributes. For instance, automatically dialled calls are subject to rules forbidding unsolicited calls without prior consent. In some countries there are also rules limiting the extent to which these calls can be abandoned or silent (especially as they then worry vulnerable recipients). Yet such calls might be M2P communications (if they consist of recorded marketing messages) or P2P communications (if they let human callers intervene when they are answered). The rules relate to the nature of the calls and not to the numbers of the callers; they would not become easier to apply if M2P numbers were in one range and P2P numbers were in another.

With that in mind, potential differences between M2M services and other services are examined here, particularly to see where they might relate to regulation.

[33] Arguably, this particular regulatory requirement for P2P end points is now more a curse than a blessing: it helps nuisance callers to disguise themselves without helping callers to hide their locations better than would the use of mobile phones.

8.2 Number portability

In principle, an M2M service provider might want to change from using one network to using another. However, until over-the-air (OTA) programming of SIM cards becomes widespread, changing networks will entail changing SIM cards and could therefore be made to entail changing the telephone numbers on the cards; if the numbers were not publicly known, the main advantage of porting the numbers instead of changing them would be avoiding provisioning operations on the support systems of the M2M service provider.

Of course, OTA programming might become widespread. In that case, porting M2M numbers would certainly be preferable to changing M2M numbers when changing SIM cards, and the requirement for M2M number portability would have great practical value. However, the current mobile number portability system might not be suitable for, or inexpensively extensible to, porting large quantities of numbers simultaneously. In that case a number block de-allocation and re-allocation process would be appropriate, provided that the numbers to be ported were the only ones assigned in the block.

To facilitate porting by de-allocation and re-allocation, a customer might be assigned a whole block when part of the block would be enough. The resulting wastage would be smaller if block sizes were smaller (as proposed in Section 6.3) or if the customer were an M2M service aggregator that catered in single blocks for multiple M2M services.

Whether the customers of M2M service providers have rights to port M2M numbers presumably depends on whether they pay directly for the communication services underlying the M2M services. If M2M service providers bundle the communication charges into the overall prices for the M2M services, then they have contracted with the CSPs and have been assigned the numbers. However, M2M service aggregators that simply provide communication services (and parts of blocks of numbers) to small M2M service providers should let those service providers port the numbers. For this purpose we suggest that the current number portability process would be used.

We recommend that:

- the M2M service providers should have the right to port numbers, in accordance with EU Regulations
- ComReg, after discussions with the CSPs, should institute a number block de-allocation and re-allocation process for porting numbers in quantities larger than those that can be ported simultaneously using the mobile number portability system.

8.3 Emergency calls

If the communication service underlying an M2M service is capable of originating voice calls to numbers in the National Numbering Plan then emergency calls should be feasible. Customers ought to be told which machines can make them or have facilities that let customers make them.

To avoid perplexing the Emergency Call Answering Service (ECAS) providers, any machine capable of making emergency calls should indicate in the signalling that the calls are being made by a machine.[34] For the purposes of providing caller location information for the ECAS, an M2M service should be classed as a mobile service if it satisfies the requirements for mobile services in the National Numbering Conventions.

We recommend that:

- the M2M service providers should state clearly, in their contracts, at the points of sale and in the user guides for machines, which machines may originate emergency calls and which machines may let end users originate emergency calls
- the CSPs should require such statements through their contracts with the M2M service providers
- the M2M service providers should ensure that emergency calls originated by machines include signalling indicators of their originations
- the CSPs should require such signalling indicators through their contracts with the M2M service providers
- the CSPs should ensure that emergency calls using M2M services are treated in the same ways as emergency calls using other services for which numbers are allocated from the same number ranges.

8.4 Privacy and security

As noted in Section 5.2, customers could be baffled or irritated by calls wrongly made to, or received from, machines. They might also receive correctly made calls that they did not want; for instance, acquaintances might contrive to make machines call them as jokes, or call centre agents might repeatedly dial them automatically. The M2M service providers need to take due care to prevent such mischief; for instance, they should make comprehensive checks on the correctness of configured numbers, they should have strong safeguards against hacking into equipment, and they should train call centre agents not to bring about abandoned or silent calls.

We recommend that:

- the M2M service providers should take measures that limit the chance that communication service users would receive unwanted M2M communications or violate the security of M2M systems
- the CSPs should require such measures through their contracts with the M2M service providers.

[34] Inserting a suitable flag is already a requirement for eCall. Machines that are not bound by the eCall rules should insert a different flag.

9 Conclusion

In this section we provide a summary of our conclusions and recommendations.

9.1 The role of telephone numbers

There is a general recognition that IP addresses will be used in the long term for addressing communicating machines. There is also a widespread expectation that telephone numbers will be used for several years.

Early M2M systems depended on fixed networks and often used the geographic numbers of existing fixed lines. Future M2M communications on fixed networks are likely to use broadband and IP addresses; telephony and telephone numbers for M2M should be irrelevant. Future M2M communications on mobile networks might well also use broadband and IP addresses, but if they require 2G or 3G protocols, then they may require telephone numbers.

There are various arguments for allocating numbers for M2M services from new ranges. However, they do not seem to be as persuasive as might be expected, unless M2M numbers must be longer than other numbers to make enough of them available.

9.2 Number supply and demand

Mobile number supply and demand are particularly relevant to M2M communications. In principle, 24 million mobile numbers would suffice indefinitely for P2P communications (especially as the Irish population is below 6 million). However, at the current rate of allocation, P2P communications alone will easily exhaust the supply of seven-digit subscriber numbers available for mobile services. Numbers would need to be conserved to prevent rapid depletion.

Demand for M2M numbers must be added to this demand for P2P numbers. This is uncertain; one estimate points to 26 million numbers, which is high, but not implausibly so. It assumes that Ireland does not provide quantities of M2M numbers (for extraterritorial purposes) greatly disproportionate to its economic size.

Putting these points together, the existing mobile number ranges could supply enough numbers for M2M and mobile communications, if numbers were conserved and extraterritorial requirements were limited.

9.3 Options for providing numbers

The demand for M2M numbers is, as yet, unclear. It could almost certainly be met by introducing long subscriber numbers. If doing so had no cost then that would be the obvious thing to do. In the absence of clarity about demand and cost, the strategy for providing M2M numbers is constructed

from options for number ranges and number lengths appropriate to different scenarios. These allow for varying degrees of success in number conservation and varying levels of demand. If number conservation techniques were effective, then at least 20 million M2M numbers could occupy the mobile number ranges. If the mobile number ranges were ultimately insufficient, then there would be particular M2M number ranges; the subscriber numbers in those ranges might have seven digits or ten digits, depending on demand.

We draw conclusions and make recommendations about possible options for providing numbers as follows.

- **Option 1: using existing number ranges**. This can supply enough M2M and mobile numbers if the demand for them from CSPs does not continue to expand ahead of use by customers and there are no very large extraterritorial requirements for M2M numbers. It has the lowest cost among the options. However, unless numbers are conserved, the existing number ranges will ultimately be inadequate. We recommend that:

  — ComReg should usually allocate M2M numbers from the existing mobile number ranges until projections demonstrate that shortages will occur
  — ComReg should, at intervals of two years, review whether such shortages might occur within the following four years
  — ComReg and the CSPs should introduce number conservation techniques, with the objective of ensuring that such shortages do not occur
  — ComReg should, exceptionally, allocate M2M numbers from the IP-based number range if the existing mobile number ranges are inappropriate because of requirements in the National Numbering Conventions
  — ComReg should require applications for future allocations to distinguish between M2M, P2P, P2M and M2P communications and to avoid including a mix of both M2M and P2P communications as purposes for specific allocated number blocks n
  — the CSPs should notify ComReg about changes in the purposes for which allocated numbers are used.

- **Option 2: using new number ranges with subscriber numbers having seven digits**. This can be adopted if the demand for M2M numbers seems likely to make the existing number ranges inadequate for M2M and mobile numbers together. Adoption would take, at most, two years and would have a low cost. We recommend that:

  — ComReg should allocate seven-digit subscriber numbers from new M2M number ranges only if projections demonstrate that shortages amounting to at most 20 million numbers will occur and can be avoided by doing so
  — ComReg should reserve at least two number ranges among 072, 073, 075, 077, 078 and 079 in case M2M numbers are ultimately allocated from new number ranges.

- **Option 3: using new number ranges with subscriber numbers having at least eight digits**. This can be adopted if the demand for M2M numbers seems likely to grow well in excess of current projections, perhaps because of very large extraterritorial requirements for M2M numbers. It requires modifications to support systems that would take some time and have some cost if they were implemented before the systems were due for upgrades. We recommend that:

  — ComReg should allocate ten-digit subscriber numbers from new M2M number ranges only if projections demonstrate that shortages amounting to at least 20 million numbers will occur otherwise
  — the CSPs should include in their upgrade programmes for network and support systems the removal of limitations on the lengths of subscriber numbers, in case M2M or other subscriber numbers are ultimately required to have at least eight digits
  — ComReg should, at intervals of two years, review progress towards removing such limitations.

The proposed strategy permits the introduction of new number ranges and longer numbers for M2M communications to be delayed until the need is more apparent and the cost is more confined. We assume that Option 1 is adopted initially, but we make recommendations about actions related to Options 1, 2 and 3 that should be taken alongside Option 1. If number shortages arise despite the actions related to Option 1, or if the other reasons for allocating M2M numbers from new ranges are more significant than they currently appear, one or both of Options 2 and 3 can be adopted.

9.4 Techniques for conserving numbers

If the allocation of mobile numbers continued at its present rate, even without the boost due to large quantities of M2M numbers, by 2020 extra mobile number ranges might be needed, if the existing numbers are not conserved. Few ranges are well suited to mobile numbers, so longer numbers could be needed even for P2P communications.

We draw conclusions and make recommendations about possible techniques for conserving numbers as follows.

- **Technique 1: setting effective utilisation targets**. This is the starting point in avoiding number shortages: ComReg would agree a target to improve efficiency in the use of numbers with the CSPs, each of which would devise its own ways of reaching the target. Modest process changes (if necessary) could raise the activity ratio from the current 25% to 35%, which, with the projected level of use of numbers, could be adequate. We recommend that:

  — ComReg, after discussions with the CSPs, should set a target lower bound for the activity ratio for M2M and mobile numbers that is at least 35%
  — the CSPs should devise and implement plans for ensuring that this target is reached
  — ComReg should perform detailed regular audits of the quantities of numbers in use
  — ComReg should check applications for future allocations of M2M and mobile numbers for evidence that the demand could not be met partly or wholly from prior allocations and that the plans for reaching this target are being implemented effectively.

- **Technique 2: reducing the sizes of blocks in allocations**. This could encourage consideration of whether extra numbers were really needed and could cater efficiently for small and experimental providers of M2M and other communications. We recommend that:

  — ComReg should set a sub-range holder block size for M2M and mobile numbers that is at most 10 000 from a date defined after discussions with the CSPs
  — the CSPs, in their upgrade programmes for network and support systems, should include the introduction of this sub-range holder block size.

- **Technique 3: charging for numbers**. Numbers will be conserved only if the long-term benefits of doing so can be recognised. To offset short-term pressures on the CSPs and achieve an equitable distribution of any costs, charging for numbers might ultimately be appropriate, though it is not called for yet. It would ensure that CSPs had equivalent incentives to raise the activity ratio. We recommend that:

  — ComReg should, at intervals of two years, review whether there should be charges for M2M and mobile numbers.

- **Technique 4: shortening the interval between assignments**. Inevitably there will be many M2M and mobile numbers in quarantine between assignments to different customers. However, efficiency in the use of numbers could be improved by ensuring expeditious entry into, and exit from, quarantine. We recommend that:

  — ComReg should take advantage of any reduction in the opt-out period to reduce the quarantine period for M2M and mobile numbers
  — the CSPs should ensure that numbers pass rapidly to being in quarantine after cessation of service (for postpaid accounts) or at the end of the inactivity period (for prepaid accounts).

- **Technique 5: retrieving unused numbers**. Operating processes ought to pay heed to the circumstances in which assigned numbers are unused and could be retrieved. For instance, any M2M and mobile numbers in the distribution chain that never enter into use should ultimately be made available again. Similarly, the number portability process needs to ensure that ported numbers that are subsequently taken out of use do not disappear, but are made available for re-assignment. We recommend that:

  — the CSPs should limit the extent to which M2M and mobile numbers are distributed before assignment to customers
  — the CSPs should cancel SIM cards that include numbers and that remain unsold and unused for some time
  — the CSPs should make arrangements to ensure that ported M2M and mobile numbers that subsequently stop being assigned to customers are returned after quarantine, automatically and immediately, to the sub-range holders for re-assignment.

Techniques 1, 2 and 3 largely entail actions by ComReg that might encourage CSPs to conserve numbers; Techniques 4 and 5 largely entail actions by CSPs in response to that encouragement.

9.5 Numbering distinctions

If different initial digits of the numbers in a range were used to identify different kinds of M2M communications, the range would become fragmented and the opportunities for using numbers efficiently would be reduced.

Forcing some M2M numbers to be intended for fixed services seems to have little value, because distinctions between such numbers and other numbers would not help CSPs, M2M service providers or customers. Also, it could impede innovation, as M2M service providers would be obliged to treat fixed equipment differently from mobile equipment. We recommend that:

- ComReg should not single out a class of M2M numbers for fixed services, but should note the relevance of the IP-based number range if not all M2M services can be regarded as mobile services for the purposes of number allocation.

Forcing some M2M numbers to be intended for premium-rate services seems to have little value, because existing regulations appear to be adequate. Also, it could cause confusion, as such numbers and existing premium-rate numbers would not have clearly different purposes. We recommend that:

- ComReg should not single out a class of M2M numbers for premium-rate services, but should monitor how M2M numbers are used in conjunction with premium-rate services.

9.6 Regulatory requirements

M2M service providers should be able to port M2M numbers assigned to them. Customers of M2M service providers should be able to port M2M numbers if they hold the contracts for the communications services underlying the M2M services. We recommend that:

- the M2M service providers should have the right to port numbers assigned to them, in accordance with EU directives
- ComReg, after discussions with the CSPs, should institute a number block de-allocation and re-allocation process for porting numbers in quantities larger than those that can be ported simultaneously using the mobile number portability system.

Customers of M2M service providers ought to be told which machines can make emergency calls or have facilities that let customers make emergency calls. If the machines themselves make the calls, they should indicate as much in the signalling. We recommend that:

- the M2M service providers should state clearly, in their contracts, at the points of sale and in the user guides for machines, which machines may originate emergency calls and which machines may let end users originate emergency calls
- the CSPs should require such statements through their contracts with the M2M service providers

- the M2M service providers should ensure that emergency calls originated by machines include signalling indicators of their originations
- the CSPs should require such signalling indicators through their contracts with the M2M service providers
- the CSPs should ensure that emergency calls using M2M services are treated in the same ways as emergency calls using other services for which numbers are allocated from the same number ranges.

Customers could be baffled or irritated by calls wrongly made to, or received from, machines. The M2M service providers need to take due care to prevent such mischief (by suitable equipment configuration and protection, for example). We recommend that:

- the M2M service providers should take measures that limit the chance that communication service users would receive unwanted M2M communications or violate the security of M2M systems
- the CSPs should require such measures through their contracts with the M2M service providers.

Annex A List of abbreviations used in this report

Figure A.1: Terms used [Source: Antelope Consulting/Analysys Mason]

Abbreviation	Full term
2G/3G/4G	Second/third/fourth-generation (mobile telephony)
CEPT	European Conference of Postal and Telecommunications Administrations
CLI	Calling line identity
CSP	Communication service provider
EC	European Commission
E.164	ITU-T recommendation, The international public telecommunication numbering plan
eCall	M2M system for dialling emergency services which must be installed in all new cars in EU from 2015 onwards
ECC	Electronic Communications Committee
ECAS	Emergency Call Answering Service
ECC	Electronic Communications Committee
EU	European Union
EUR	Euro
GDP	Gross domestic product
IP	Internet Protocol
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
ITU	International Telecommunication Union
LTE	Long Term Evolution
M2M	Machine to machine
M2P	Machine to person
MHz	Megahertz
MNC	Mobile network code
NAP	Numbering Advisory Panel
NAT	Network Address Translation
P2M	Person to machine
P2P	Person to person
QR Code	Quick Response Code
SIM	Subscriber Identity Module
SMS	Short Message Service