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Review of Mobile Numbering Resources:

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Contents

1. Executive Summary

The Commission for Communications Regulation ("ComReg") is responsible for ensuring the efficient management and use of the national numbering scheme. Technology and market developments in areas such as the Internet of Things ("IoT"), machine-to-machine ("M2M") communications and Over-The-Top ("OTT") services may result in increased demand for Irish mobile numbering resources assigned by ComReg. ICC was commissioned by ComReg to conduct a review of the mobile numbering resources, including an assessment of potential future demand from IoT, M2M and OTT services for mobile numbers. Furthermore, ICC was asked to consider whether new regulatory measures are needed to address any emerging demand for Irish mobile numbering resources, including the potential introduction of a new dedicated numbering range, and/or the extensions of existing mobile numbering ranges.

IoT and M2M communications involves networked devices performing actions or exchanging information with one another with minimal or no human intervention. Many current and future IoT services could provide connectivity over fixed and narrow band networks rather than over cellular networks. A proportion of M2M connections will be based on cellular technologies, meaning that some IoT/M2M devices will require a SIM card, but others will not. The most common addressing methods are telephone numbers and Internet Protocol (IP) addresses. While IP (in particular IPv6) will become more prominent in the long run for both IoT and M2M communications, telephone numbers will remain important for certain cellular based M2M services for the foreseeable future. The development of wide area M2M communications will have an impact on the numbering resources as devices need to be uniquely addressed for the exchange of data. Examples of M2M products and services relying on telephone numbers include: connected and automated vehicles, logistics for tracking shipping containers, home security and heating systems, smart meters, and smart city traffic management systems.

OTT refers to content, services or applications provided to end-users over the public internet. Some OTT applications could act as a replacement to existing electronic communication services, and therefore could potentially require mobile numbering resources to provide end-to-end connectivity to their subscribers. However, our analysis shows that the vast majority of OTT services currently do not require mobile number resources and therefore are not expected to result in significant demand for numbers over the next few years.

The continued growth of IoT, M2M and OTT has the potential to introduce a range of new innovative products and services. Market opportunities are fuelling the growth of M2M services and applications in areas such as transportation, industry, health, wearables, smart homes and smart cities.

Mobile numbering ranges are currently used for M2M

Currently, Irish Mobile Operators (MOs) are using numbers assigned from existing mobile number ranges in Ireland (083, 085, 086, 087 and 089 ranges) for M2M communication. In 2016 ComReg introduced a range of conservation measures to promote more efficient management of the numbering resources by MOs. Although the conservation measures should promote a more efficient use of existing mobile number ranges and meet demand at a national level, this report also considers the potential future demand for Irish mobile numbering resources for international M2M communications (i.e. national mobile numbers being used on an extra-territorial basis).

Also, MNOs and M2M/IoT service providers can, and do, use international ITU numbering resources, and national numbering resources assigned by countries other than Ireland. However, access to numbering resources has proven challenging for some M2M/IoT service providers, and the length of time required to negotiate international roaming agreements using these numbers has acted as a barrier to their adoption.

M2M stakeholder ecosystem more complex than person-to-person ("P2P")

M2M involves a wider stakeholder ecosystem than P2P. BEREC's definition of M2M and taxonomy is a useful reference point. Two main differences are:

1. M2M can often involve the presence of an intermediary agency between the connectivity service provider (e.g. MO) and the consumers, what BEREC refers to as the 'IoT Service Provider'. This entity typically provides the IoT platform and/or other related IT services and solutions; and
2. M2M involves two distinct consumer groups: IoT users (e.g. car manufacturers that incorporate M2M technology into their cars), and end users (e.g. owners / drivers of the car) analogous to the owner / user of the phone in the P2P market. IoT users are not present in the P2P ecosystem.

Having a different stakeholder ecosystem than P2P is significant because:

- It introduces additional players, IoT Service Providers, who may have demand for mobile numbering resources, whether sourced directly from ComReg or indirectly via an MO, and
- IoT users that switch between IoT Service Providers will likely be switching numbers for large volumes of devices in unison.

ComReg also assigns another class of identifiers know as a Mobile Network Code (MNC). These are used by MO's to construct the 'international mobile subscriber identity' (IMSI) for signalling and routing within mobile networks. IMSIs allow MOs, and potentially IoT Service Providers, to produce their own SIMs and therefore to negotiate international roaming agreements. With respect to M2M, an important question is whether ComReg should assign MNC to IoT Service Providers, and how this might impact on the MNC resource, considering that ComReg only has 100 of these two-digit numbers to assign.

Emerging demand from M2M services could place unprecedented demand on the mobile numbering resource

ICC has produced a number of forecasts to determine the extent to which M2M could place pressure on existing mobile ranges, which currently have 14m numbers free for assignment:

- The current demand for mobile numbers in the 083, 085 086, 087 and 089 ranges is predominantly focussed on P2P communication services. Currently, M2M mobile subscriptions represent about 12% of total mobile subscriptions. While P2P subscriptions are growing at about 1% per year, Irish MOs' M2M mobile subscriptions are growing at a much faster rate of about 20% per year.
- Based on current M2M mobile subscriptions trends from ComReg's Quarterly Reports, forecast demand for M2M numbers ranges between 2.1m and 3.9m numbers by 2022, which represents a conservative estimate given that it only includes MOs that are currently assigned numbers. While this level of demand would not exhaust the mobile numbers, it would certainly bring forward such a date, and must be considered alongside potential future growth in demand for mobile numbers for P2P communication.
- Demand for numbers from M2M/IoT Service Providers for extraterritorial use has the potential to place unprecedented demand on the Irish mobile numbering resources. This is due to the sale and use of M2M products and services transcending national borders, such that the geographic placement of an M2M device will not necessarily correspond with the origin of the number resources used to service it. From interviews conducted with a small number of M2M/IoT Service Providers currently active in Ireland, demand is forecast to increase from 1.6m

in 2018 to 38m in 2022. Such demand could well exhaust all available mobile numbers from existing ranges before 2020. One area that could drive such demand is the automotive sector, a noticeable example being the European Commission's E-Call directive, which requires all newly registered motor vehicles to be equipped with an eCall emergency call system from 2018. ICC forecasts 1.2m connected vehicles in Ireland by 2022.

- Taking a global perspective and assuming that demand for Irish numbers represents a fixed share of projected global M2M growth, it is forecasted that total demand for Irish numbers could reach as much as 70m by 2022.

Emerging demand for numbers from M2M services could lead to a significant risk that the existing Irish mobile number ranges become exhausted within the next few years if operators continue to use existing ranges for M2M. On the other hand, in the absence of M2M related demand, the mobile numbering ranges are likely to meet expected P2P related demand for numbers for the foreseeable future; particularly given the continued implementation of conservation measures as agreed between ComReg and the Irish MNOs. In considering the most appropriate course of action for ComReg to adopt, a number of **key issues** were considered by ICC.

- **Efficient management of the numbering resource**. Should the existing mobile numbering ranges become exhausted due to their use for M2M, this may not represent an efficient management of the national numbering resources by ComReg. It is important that the existing mobile ranges remain available for the primary intended uses, P2P communication, for the foreseeable future. While the remaining mobile number ranges (e.g. 082, 084 or 088) could be opened, there is no guarantee that demand for M2M would be satisfied within these ranges, without increasing the length of the subscriber numbers. Such a number change would impose significant costs on industry and society, if it required network operators and service providers to build new numbers into their operating systems, amend and evolve current business processes, and require business users to change stationery.
- **Supporting competition and innovation**. Managing the number resource in an efficient manner allows ComReg to assign numbers to both incumbents and new entrants, supporting competition and ensuring that consumers benefit from the resulting end-user products and services, both in terms of price and choice. Ability to switch Service Providers underpins the concept of competition and of consumer choice. M2M/IoT services are among the most dynamic and their impact spreads to the entire national economy. Numbers have no production

costs, and it is advantageous to have efficient, freely-available numbering regimes that will ensure that there are minimal barriers to entry to the various downstream service markets.

- **Extraterritorial use of numbers**. Use of Irish numbers for services provided in other countries (as well as foreign numbers deployed in Ireland) is not currently explicitly addressed in ComReg's current Numbering Conditions document This could undermine the development of the M2M market in Ireland and abroad. From the point of view of the national economy, there may be opportunities to make numbers available widely, including to overseas users, without this interfering with the requirements of a national numbering system for P2P traffic.
- **M2M commercial models**. Given the different characteristics of M2M as compared with P2P (e.g. lower data rates, greater signalling requirements and propensity for extraterritorial use) there may be a case for having different commercial / tariff models in place for M2M. Having a distinct number range with M2M centric user conditions (such as those relating to service provider switching, assignment criteria and utilisation criteria) would allow for commercial terms specific to M2M/IoT to be negotiated.
- **Costs of introducing a new numbering range**. MOs would face costs associated with the implementation and utilisation of a new numbering range, particularly if the new range is longer in length than the existing 12 digit mobile numbers. However, 13 digits numbers are already in use in Ireland for accessing mobile mailboxes. Also, based on ICC discussions with Irish MOs as part of this report, it would appear that, for all but one operator, number length has becomes less of an issue over time, due to previous and ongoing systems upgrades. The costs of introducing a new numbering range must be balanced against the benefits of avoiding a number extension of existing mobile ranges, which would impose significant costs on business and broader Irish society.
- **EU regulations**. The European Commission has mandated that all newly registered cars should be equipped with emergency call answering technology from April 2018. Meeting this requirement may require extraterritorial use of numbers, whether such numbers originate from within or outside Ireland. Furthermore, the draft European Electronic Communications Code (EECC) includes a recommendation for EU member states to implement a new dedicated range for M2M. Several EU countries have already introduced (or are currently considering introducing) a dedicated ranges for M2M, generally of longer length than current Irish mobile numbers.

Considering the above issues, and the expected future demands on the national mobile numbering resource, ICC has proposed a number of recommendations for ComReg to consider, a subset of which are summarised as follows:

Main recommendations:

- **New Number Range for M2M/IoT services**; A new range should be allocated from the 08x range of the Irish national numbering resource - specifically 088 - to service providers for the purpose of providing M2M/IoT services. The proposed new 088 number range should be should be 15 digits in length (including 353 country code) and should be implemented within 12 months. ComReg should designate a specific part of the new 088 range for eCall.
- **Service Provider Switching**; Service Providers utilising national numbers for M2M/IoT resources should be required to allow their subscribers (i.e. large enterprises supplying M2M/IoT services) to switch suppliers. Such switching (Service Provider portability) should, as far as possible and where appropriate, use existing number portability processes. In addition, as there are existing and emerging technical approaches and a complex M2M/IoT stakeholder ecosystem, further study in this area is needed.
- **Eligibility for E.164 and E.212 mobile resources**; Providers of M2M/IoT services should be eligible to apply for E.164 numbers designated for M2M/IoT services and E.212 resources provided they can both justify the requirement and can demonstrate that they can manage the resources.
- **OTT Service Provider Eligibility for E.164 Mobile Numbers and E.212 resources**; Service Providers should be eligible to apply for E.164 mobile numbers and E.212 MNCs for OTT services that qualify as an ECS and have a contract with an Irish MNO to access their network, provided they can justify the requirement.
- **Extra territorial Use of Numbers**; ComReg should explicitly permit numbers and MNCs, assigned to undertakings for M2M/IoT services, to be used outside of its jurisdiction. This will support M2M services by facilitating the international nature of many such services.
- **Use of Overseas numbers in Ireland:** As with all ECSs providing services in Ireland, those providing M2M services in Ireland are required to be authorised and comply with all applicable legislation and laws, regardless of the numbers being used. These numbers may be other country numbers or global numbers in use in Ireland.
- **Use of Global Codes**: Use of global codes assigned by the ITU (Recommendations ITU T E.164.1 and E.212) to service providers, for the purposes of M2M/IoT, should be stated in ComReg's

Numbering Conditions. The use of global numbering resources has the benefits of reducing the demand on national resources. Such codes may also assist Service Providers in negotiating commercial arrangements.

- **Conservation Measures and Needs-based allocation**; Service Provides to continue to implement the agreed conservation measures. Also Service Providers should ensure that, in requesting additional resources, their approach towards managing existing resources justifies the request.

2. Introduction, Landscape and Background

2.1 Introduction

The Commission for Communications Regulation ("ComReg") is responsible for regulating the provision of electronic communications networks and services and for ensuring the efficient management and use of the national numbering resource in Ireland, in accordance with its relevant functions, objectives, duties and powers which are set out in primary and secondary legislation[1]. The effective management of that resource includes taking measures to ensure that there are enough numbers to meet current and future demand.

In its 2015 response to consultation on the Numbering Conditions[2], ComReg stated that it would engage with industry and conduct a separate review of the potential demand, eligibility criteria, and conditions of use for mobile numbering resources. ComReg indicated that the review would focus on the following mobile numbering resources:

- Mobile numbers; and
- Mobile network codes ("MNC").

Currently, only Irish mobile operators (MNOs and MVNOs) that use GSM , UMTS, and/or LTE public land mobile networks are eligible to be granted rights of use ("RoU") for Irish mobile numbering resources. However, technology and market developments in areas such as Over-The-Top ("OTT") services, machine-to-machine ("M2M") communications and the Internet of Things ("IoT") mean that other types of electronic communication service ("ECS") providers may require mobile numbering resources, leading to increased demand for such resources. Such increased demand could be addressed by the use of international (ITU) mobile numbering resources and/or national mobile numbering resources from one or more countries.

[1] The legal framework and key statutory objectives relating to number management are set out in Appendix 8 of ComReg 15/136: Numbering Conditions of Use and Applications Process document.

[2] ComReg Document 15/137: Numbering Conditions of Use and Application Process: Response to Consultation and Decision

The automotive industry is an example of an area where there may be a need to grant RoU for mobile numbers and MNC, to ECS providers that are not mobile operators. From April 2018, all new cars in the EU must be equipped with eCall technology, enabling them to make automated emergency calls in the event of an accident.

In 2016, ComReg introduced a range of conservation measures to ensure efficient use of the existing mobile ranges (ComReg Doc 16/20a). These measures have been agreed in principle with industry and are now being implemented. Although the conservation measures should help meet demand for mobile numbers at a national level, as part of this review of mobile numbering resources, ComReg has tasked ICC to consider the potential future demand for national mobile numbers for international M2M/IoT communications (i.e. national mobile numbers being used on an extra-territorial basis) and identify regulatory measures to address any emerging demand. In addition, the likely future development and growth of OTT services (including the potential growth of Wi-Fi calling) is also factored into this review.

Services that makes use of numbering resources have evolved and national numbering resources are no longer only used for Person to Person (P2P) communication services at the national level. Service providers are beginning to seek more flexibility in terms of how they can use national numbering resources to meet the requirements of international communication services such as M2M/IoT. This evolution is clearly reflected in the European Commission's draft European Electronic Communications Code ("EECC"). As an example, the draft EECC includes a proposal to allow the extra-territorial use of national non-geographic number ranges throughout the territory of the Union.

The potential demand from Irish Service Providers for numbering resources to meet the requirement for international M2M/IoT services could place an unprecedented demand on national mobile resources, and the environment in which they operate. The issue then arises: how to provide such resources that do not exhaust existing consumer mobile number ranges, but addresses the need for numbering resources from emerging services. The result is that use of a new numbering range must be considered.

2.2 Machine-to-Machine ("M2M")

For this report, BEREC's definition of M2M will be used. BEREC defined M2M as a 'generic concept that indicates the exchange of information in data format between two remote machines, through a mobile

or fixed network, without human intervention'[3]. However an ECC report[4] defines M2M communication as "…a communication technology where data can be transferred in an automated way with little or no human interaction between devices and applications". The approach that has been taken to the mandating of eCall, emergency calling in cars in Europe indicates the cases where the latter definition is the more appropriate[5].This report provides an overview of the developing relationship between M2M technologies, mobile numbering, and related regulatory policies. As a result, the nuances between M2M and the Internet of Things (IoT) do not have a significant impact on the research or recommendations in this report and will be considered together as M2M/IoT.

M2M/IoT technologies are defining an emerging market. While deployment is increasing and demand is expected to rise significantly in the next 5-10 years being driven primarily by deployment in the automotive industry[6], current deployment of M2M is not yet as ubiquitous or prevalent as anticipated. The extent to which a particular sector or segment of the M2M/IoT market will require numbering resources, as opposed to IPv6 addresses is not dependent upon the market segment but rather on the technology chosen for the implementation. That being said, there are growing markets and opportunities for electronic communication service (ECS) providers with consequent pressure on mobile numbering resources.

Implementation of M2M/IoT that support objects undertaking regular movement, especially across large areas, or periodic location changes and wireless access are likely to want to use mobile numbering resources. One of the most popular developing markets is in the transportation sector, particularly connected cars. Manufacturers are partnering with connectivity providers for SIM capabilities that enable both enterprise- and consumer-facing services, such as eCall, remote vehicle maintenance monitoring and Wi-Fi access for passengers. Mobile numbering is also enabling the development of a market in the shipping industry (connected containers) and may see growth in Smart City deployments

[3] BEREC, *Report on Convergent Services* (13 December 2010) p. 6.

[4] ECC Report 153 Numbering and Addressing in Machine to Machine Communications (November 2010)

[5] COMMISSION DELEGATED REGULATION (EU) No 305/2013 of 26 November 2012 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to the harmonized provision for an interoperable EU-wide eCall

[6] Global M2M cellular connections alone are projected to increase from 205 million in 2014 to over 1.3 billion in 2025. (Analysys Mason, *M2M and Internet of Things (IoT): Opportunities for Telecoms Providers* [6 April 2016])

(connecting legacy infrastructure or smart meters), wearables (tracking activation), or smart homes (appliance monitoring and maintenance)[7].

2.3 Over the Top ("OTT")

BEREC provides the following definition of OTT: 'content, a service, or an application that is provided to the end user over the public Internet'[8]. This definition focuses on the method of provision, but is developed further into OTT-0/1/2 categories. These categories separate OTT services depending on their classification as:

- an ECS (OTT-0),
- a non-ECS service that competes with ECSs (OTT-1) and
- a service which is not and does not compete with ECSs (OTT-2)[9].

Because OTT-2 does not involve interpersonal voice services they are not considered further in this report.

This categorisation highlights the differentiation made between OTT services that create new markets (i.e. video streaming and social media) and the market disruption caused by the likes of Skype, WhatsApp or Viber which substitute for and compete with traditional telecommunication methods[10]. The ability to ensure fair and competitive markets between traditional service providers and alternative providers of OTT communications services which utilise IP infrastructure to provide similar services, is a difficult balance. There is an acceptance by some stakeholders, such as regulatory authorities and some service providers, that the same services (i.e. voice calling) should be subject to 'broadly the same

[7] For a more detailed overview and information about market opportunities, see Annex E.

[8] BEREC, *Report on OTT Services* (January 2016)

[9] BEREC, *Report on OTT Services* (January 2016)

[10] This perspective is mirrored in other definitions and views of OTT such as ITU-T Study Group 3's definition provided in the document "Economic Impact of OTT (TD346)" (March 2016).

regulatory obligations'[11]. The difficulty here is the need for proportionate regulations, not necessarily identical regulations, to take account of the types of services being offered.

While implementation of OTT services in all categories present broader regulatory challenges overall – such as Net Neutrality and comparable regulations – those services categorised as OTT-0 are not expected to have a significant impact on mobile numbering resources when compared with M2M. For instance, service providers such as Vodafone, O2, and 3 are offering Wi-Fi services to their customers which allows Wi-Fi calling and switching between networks and technologies to ensure quality of service and accessibility. Wi-Fi services demand for numbers can be flexible and have minimum impact upon current numbering resources. These services are provided by operators and service providers and utilise the mobile number that the user has allocated for the PSTN for identification. In contrast, Internet companies, such as WhatsApp and Viber, have the flexibility to utilise user accounts or re-use the end users current mobile numbers for identification, relieving possible stress points on mobile numbering resources[12].

2.4 Benchmarking

In order to provide international perspective, ICC reviewed the number requirements and practices as they apply to M2M/IoT and OTT services in several other countries. In addition, a series of targeted questionnaires addressing specific aspects of numbering provision for M2M/IoT and OTT services was circulated by ComReg to contacts within various regulatory authorities via the CEPT ECC's Working Group on Numbering and Networks (WG NaN). From a preliminary selection of 40+ EU and other countries, six prospects were agreed as being worthy of further consideration, namely Belgium, Denmark, Germany, the Netherlands, Norway and Singapore. These were chosen based on their comparability to Ireland in terms of socio-economic factors and observed regulatory approach, the existence of specific and identifiable regulatory provisions for the allocation and management of numbering resources for M2M/IoT and/or OTT services, and the likely availability of publicly-accessible information on any such provisions.

[11] BEREC, *Report on OTT Services* (January 2016) p.4.

[12] See Annex E for more detailed information on OTT markets and Wi-Fi First providers.

While the majority of countries in the final six-country sample have implemented dedicated M2M number ranges, there are a variety of approaches. Belgium and the Netherlands have transitional arrangements for dedicated ranges whereas Germany has considered implementation of a dedicated range but has not yet found it necessary. In Singapore, depending on licensee status, network operators and service providers have different access entitlements to dedicated M2M and IP telephony number ranges. In the Netherlands, a previously-unallocated 12-digit range was selected for M2M use because it had the largest free capacity and has future potential for expansion to a 100-million number pool. This is partially based on the reduced requirement for numbers to be 'user friendly', permitting use of numbers larger than 12 digits. Of the 22 respondents to the WG NaN questionnaire, some nine presently maintain dedicated E.164 mobile numbering resources for M2M, ranging between 8 and 13 digits in length excluding country prefixes for international dialling[13]. Of these, four adopted 12-digit number ranges with three using 13-digit formats.

The Netherlands also has interesting approaches to Mobile Network Codes (MNCs), which are available to non-MNOs with connectivity requirements, such as connected cars, smart metering, etc. In an explanatory note to a Ministerial Decree, it was noted that the linking of SIM cards to public wireless networks was increasingly constituting an obstacle to switching between service providers by users of large-scale applications, not least M2M applications with embedded SIM cards[14]. Various studies of the emerging M2M market were quoted as identifying this problem as an obstacle to a positive roaming services market, with an estimated cost to the Dutch economy of between €50 million and €70million to facilitate some 5% of M2M users switching service providers in one year. Cost issues aside, heightened demands relating to the quality, reliability and continuity of M2M communication were felt to make rapid and reliable network switching increasingly important to both M2M service providers and the public sector. By decoupling the use of SIM cards from the use of public network elements, and so allowing end-users or their chosen intermediaries to administer the necessary MNCs (and thus their SIM cards) themselves, it was considered that present restrictions to efficient switching could be removed without creating an enhanced risk of exhausting the supply of MNCs. The country's IMSI numbering

[13] 10 to 15 digits including international prefixes

[14] See s3 of Decree of the Minister of Economic Affairs of 3rd March 2014, no. ETM/TM/14024019, containing amendments to the Numbering Plan for international mobile subscription identities (IMSIs) relating to the use of IMSIs by private networks at https://www.government.nl/documents/annual-reports/2016/02/16/decree-change-of-imsi-number-plan-for-private-networks

plan was also altered with regard to use of IMSIs by private networks. This includes measures facilitating shared MNCs, aiding switching between service providers and use of e-SIMs, two blocks of MNCs dedicated to large-scale or co-operatives of M2M users, and one block for commercial use by co-operatives to provide comparable services to an MVNO and use by public bodies fulfilling statutory obligations.

In Belgium also, there is prospective widening of E.212 eligibility requirements to include non-MNOs with a realistic intention to use MNCs, regulatory reasoning including the development of new services and value chains not foreseen at the time of framing the original legislation covering number allocation procedures, the ongoing retention of which may complicate market and technical innovation and retard market development[15]. As with the Netherlands, BIPT referred to the example of the deployment of large numbers of M2M-connected smart meters by public utilities providers, each with their own distinct SIM card. Under established number allocation rules, any change in the provider of mobile connectivity services would require the replacement of every SIM, with concomitant time and cost implications, whereas direct assignment of the MNC to the meter network provider would eliminate this necessity. For the moment, however, the implementation of these proposals has been delayed pending possible adoption of the proposed European Electronic Communications Code. During early 2017, the Belgian authorities undertook a public consultation on the numbering aspects of the eCall service due to be required on all new road vehicles sold in EU Member States from the second quarter of 2018, questions including the regulatory treatment of eCall services and likely options for E.164 and E.212 MNCs.

A summary of the situation in each of the benchmark countries is given below. A detailed summary of research findings is contained in Annex B.

	Dedicated numbering resources	Dedicated number length	E.164 and/ or E.212 use	Allow M2M use outside dedicated range	extraterritorial use allowed	Restricted access to dedicated numbers	Price Discrimination	Rules for OTT numbering use
Belgium	yes	11-digit non-geo	E.164 E.212	limited	in progress	minimal restrictions	low cost dedicated M2M	no
Denmark	yes	12-digit non-geo	E.164 E.212	no	no restrictions	minimal restrictions	low cost dedicated M2M	comparable obligations
Germany	no	n/a	E.164 E.212	n/a	few restrictions	some restrictions	no	comparable obligations

[15] See s8 of BIPT's November 2014 Consultation on numbering issues at http://www.bipt.be/public/files/fr/21535/Public%20synth%20analy%20consult%20review%20KB%20N%20FR.pdf

					(but may be repealed at regulator's discretion)			
Netherlands	yes	12-digit non-geo	E.164 E.212	limited	no restrictions	some restrictions	low cost dedicated M2M	dedicated non-geo range
Norway	yes	8-digit 12-digit	E.164 E.212	no (mobile #)	not allowed	some restrictions	no	comparable obligations (dedicated range under consultation)
Singapore	yes	13-digit non-geo	E.164 E.212	yes	Considered on case-by-case basis	some restrictions	dedicated M2M range has first 3 allocations free-of-charge	IPT ranges & comparable obligations

Table 1 Overview of Benchmark Countries

In general, the trend can be seen towards the provision of dedicated numbering resource for M2M applications, whereas requirements for OTT applications tend to be met from normal mobile number ranges. While not all the jurisdictions surveyed require that all M2M activities are provisioned from the associated dedicated range, in only one case were no limitations imposed, most allowing only restricted use by M2M applications of non-dedicated number resources. Conversely, most jurisdictions imposed some access restrictions on dedicated M2M number resources, though most compensated at least in part by reducing pricing levels compared with those for comparable numbers for other uses. The question of extraterritorial use of national number resources for M2M applications is one where there appears to be less regulatory consensus, with only two regulators out of the six applying no restrictions, two applying some restrictions, one moving towards its enablement and one continuing not to allow extraterritorial use.

In addition, regulatory practices in Ireland were reviewed to find possible bottlenecks or issues that may accrue as demand for numbering grows. Special attention was given to requirements that enable policies that ensure numbering resources can be utilised in support of innovation and competition. This includes customer and consumer protections, roaming, and what is generally known as portability. Portability is redefined here to 'service provider portability' and more specifically relates to the porting of large number blocks between carriers at the enterprise level, as opposed to consumer level number portability. This research fed into the subsequent options developed for Ireland's own mobile numbering management in M2M and OTT spaces.

The remainder of this report sets out more detailed analysis in respect to the emerging demand for Irish mobile numbering resources, and also identifies a range of regulatory measures to address this demand.

This report is laid out as follows:

- Section 3 characterises the demand for mobile numbering and identification resources
- Section 4 identifies and analyses the various numbering options
- Section 5 makes Recommendations based on the characterisation of the demand and the options on numbering that have been analysed

The report includes a number of annexes containing supplementary material:

- Annex A contains the methodology for country selection to identify comparable jurisdiction benchmarking
- Annex B presents the results of applying the benchmarking methodology in comparable jurisdictions
- Annex C contains further characterisation of the demand presented in Section 3
- Annex D describes identifier work streams and Standards development work areas
- Annex E outlines M2M and OTT uses and market opportunities
- Annex F provides a list of abbreviations used in this report
- Annex G provides a list of figures in this report .

3. Characterisation of Demand

3.1 Overview

M2M

The current demand for mobile numbers in the 083, 085 086, 087 and 089 ranges is predominantly focussed on P2P communication services. This, despite some anomalies and issues that are addressed later in the report, makes the 08X range synonymous with mobile communications. Also, in the absence of other alternative ranges, these P2P ranges also include M2M/IoT allocations.

At the end of Q4 2016, 23.8 million mobile numbers had been allocated to MNOs and MVNOs for 5,969,928 mobile subscriptions (including mobile broadband and M2M)[16]. This left 14.199 million free mobile numbers remaining across these ranges. This situation has largely remained unchanged since a previous study carried out for ComReg by Analysys Mason,[17] where at the end of Q1 2015 23.6 million numbers had been allocated for 5,770,638 mobile subscriptions.

Previous assessments carried out by, or on behalf of ComReg of the demand for mobile numbers have considered the use of these consumer mobile number ranges to include demand for M2M. In this report, it is proposed that demand for M2M/IoT for telephone numbers can be met from a separate 08x range for the reasons that are cited later. The rationale for a separate range, with a different number length and specific Conditions of Use, lessen the potential negative impact on the numbering estate.

OTT

The emergence of alternative services that could drive demand for consumer mobile number ranges has yet to materialise. This is due to two major factors:

1) the governance that exists on the Conditions of Use that are associated with mobile numbers, and
2) service providers seeing no requirement to use such numbers.

[16] Irish Communications Market Quarterly Data (ComReg 17/15R)

[17] Analysys Mason Report For ComReg Conservation Measures to meet future demand for Mobile numbers (ComReg 16/20a)

The potential impact of OTT on demand for mobile numbers is dealt with separately. Setting aside the possibility of the emergence of nomadic services which utilise geographic numbers, the arrival of OTT services that would require telephone numbers (and this does not apply to all OTT services) would have little impact on increasing demand for mobile numbers. In fact, most OTT services that exist are complimentary to, and not a replacement of, current telecommunication services.

Other potential demands for mobile numbers to support P2P communication services, such as utilising Wi-Fi as an access mechanism, has not materialised to any degree that has resulted in an increase for demand for mobile numbers. Therefore, given that no significant known demands from OTT services for mobile numbers have emerged there are sufficient mobile numbering resources going forward, including the demand for OTT as discussed further in Section 3.2, beyond 2022.

Extending the lifetime of availability for mobile numbers from the above ranges is possible with the deployment of the conservation measures that have been identified in previous reports for ComReg. In that respect, a re-examination of previous work done on behalf of ComReg shows that previous estimates of mobile demand and allocation have remained accurate in the last two years. As a result, we can confirm the conclusion of those previous reports that the current approach of applying conservation measures for managing national numbers will adequately meet future demand for mobile numbers for P2P communication services. We can also confirm that no additional conservation measures are necessary at this time.

With proper monitoring of allocations and the implementation of suitable measures to secure efficiency of utilisation by service providers, at predicted average levels of growth present mobile number resources should prove adequate to meet likely demand over the next five years or so without the need to open-up additional number reserves. It should, however, be borne in mind that if changes in demographics, technologies, market offerings or other factors significantly alter levels of service uptake, an entirely possible scenario given the relative newness of OTT services, this could have a notable effect upon demand for mobile number resources and any concomitant exhaustion point.

3.2 M2M

Despite the current interest in the M2M/IoT sector, and resultant volume of commentary and analysis, deriving realistic predictions of future demand poses significant challenges. Raw data is spread over many disparate sources, while many detailed market predictions/statistics are in the form of private analyst reports rather than public-domain information. From what information is publicly available, there exist considerable differences between estimates and projections from different sources. These differences are hardly surprising, given that the M2M sector is in an early development state. There is little consensus over the exact nature of the market impact for M2M.

Predicting likely demand for numbers for M2M services cannot be satisfied by a straightforward translation of connection/subscriber numbers. Not all M2M connections will be served by mobile technologies. Some, for example, will link multiple end devices to a hub using wireless mesh technologies, with a single consolidated connection providing backhaul. Implementation approaches for M2M are still evolving. The approaches to connectivity will be influenced by the commercial decisions taken on deployment of equipment and implementation of services. To the extent that both E.164 and E.212 numbers are required by service providers, then ComReg should facilitate the allocation of such resources in support of innovation. In both cases, the proportion of M2M connections served by mobile technologies is likely to vary substantially across market sectors and technologies, across geographies, and over time.

In an internationalised environment -- with the sale and use of products and services transcending national borders, and the international use of number resources through extraterritorial use -- the geographic placement of an M2M device will not necessarily correspond with the origin of the number resources used to service it.

This then places a demand on national resources in two ways. First potentially using the numbering resources in the country of manufacture, and so distorting the use of that country's resources to support M2M/IoT. Whether that is sustainable either through the rules of the country allowing the continued use of these resources outside of their location, or through availability of resources in the longer term could be questionable.

Second is to alleviate such a distortion upon one country's resources by allowing multiple national numbering resources to be allocated to the same SIM at the time of manufacture, from which the most appropriate national resource could be selected with the deployment of the M2M/IoT service. In both cases permitting extraterritorial use of a specific range of numbers for M2M/IoT reduces both the distortion of the demand for national resources of a single country and the potential wastage from using resources of multiple countries.

InterConnect undertook three separate analyses of potential demands imposed by M2M applications upon Irish mobile numbers:

1. Analysis of historic M2M mobile subscriptions data in Ireland (as published by ComReg in its Quarterly Key Data Reports) and trending this forward over time using a variety of growth scenarios. This approach should deliver an effective 'lower limit' prediction of demand for Irish mobile numbers;
2. Considering requests that ComReg has received from M2M Service Providers for new blocks of mobile numbers to meet their requirements to develop M2M products and services; and

3. Developing predictions for a potential upper limit of demand for Irish mobile numbering resources, based on assessed levels of M2M market activity at pan-European and global levels. This includes an analysis of the likely accessibility to such activities by numbers from overseas countries used on a extraterritorial basis, and the assumed degree to which Irish mobile numbering resources might fill the resulting demand.

The methodologies, supporting data and assumptions for each are discussed more fully in the accompanying Annex C.

Using a variety of growth trend scenarios, InterConnect's extrapolation of current service provider activity suggested an M2M-driven cumulative demand for Irish mobile numbers of between 2.1 million and 3.9 million by 2022. However, taking into account potential demand from Irish and International M2M service providers currently not allocated (but have requested) Irish national number resources, the cumulative demand for Irish mobile numbers could be 38.4 million numbers by 2022.

The sharp increase in predicted annual demand for Irish mobile numbers for M2M services over and above the 2015-2017 trends recorded by ComReg in its *Quarterly Key Data Reports* may be attributed to the intended deployment by the service providers of such numbers in extraterritorial use outside Ireland. One particular driver of demand in this regard is the automotive market, the extraterritorial use of Irish national numbers overseas being regarded as desirable in terms of aspects such as reducing the complexity of carrier relations and the type of services being offered. This level of demand would exhaust existing mobile ranges before 2020.

Taking the same external estimates of likely rates of growth in the numbers of mobile M2M connections and applying them to an assessed global potential demand for mobile numbers for M2M services -- along with an estimation of what proportion of that demand might be satisfied from Irish national resources -- provides an overall upper-limit demand prediction of between 21 million and 70 million numbers in M2M use by 2022, dependent upon which baseline and growth scenario is adopted[18].

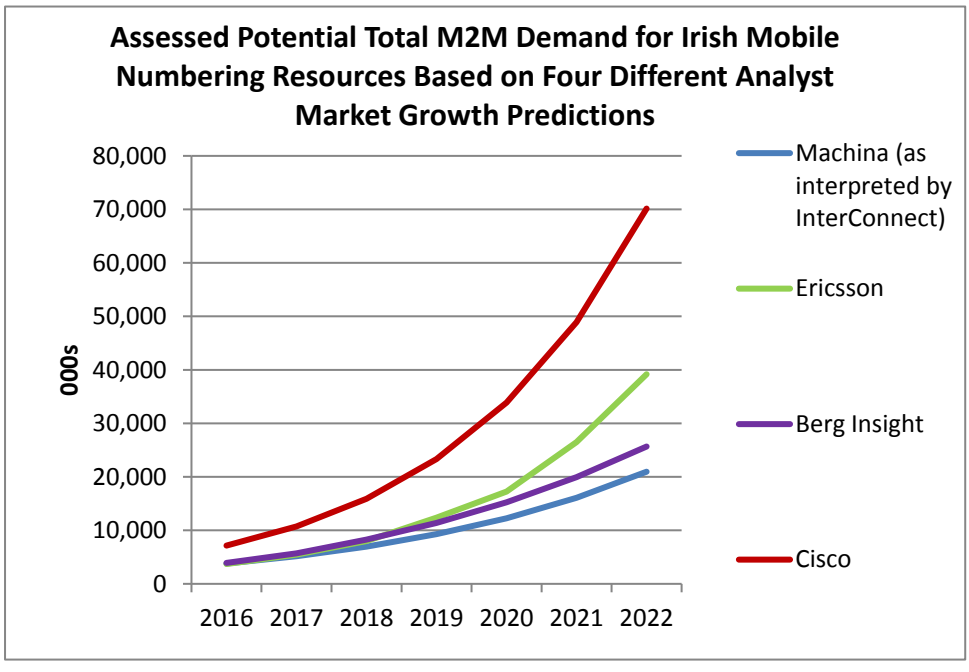

Figure 1 Assessed Potential Total M2M Demand for Irish Mobile Numbers

[18] Equating to a maximum annual gain of between 4.8 and 21.2 million numbers.

The variation between lower and upper limits reflects several factors, not least of which are the underlying uncertainties in the extent of growth in the M2M market. These factors also include the extent to which demand for numbers for overseas applications might be satisfied from Ireland.

There is a difference in scale between these demand predictions for Irish mobile numbers to serve M2M applications and previous forecasts of M2M connections in Ireland.[19] Understanding the difference between the concept of Irish-based M2M connections and demand for numbers to serve M2M applications regardless of geographical location is crucial. In this report, even the predictions based on potential activity by players in Ireland are believed to include considerable appropriations of numbering resource presumably intended for extraterritorial use. The assessed potential total demand predictions examine the likely global demand for Irish mobile number resources. This extends the projection beyond just those players presently using Irish mobile numbers in an extraterritorial capacity.[20]

While there can be little doubt about levels of industry and consumer interest surrounding the whole field of M2M/IoT, there continues to be relatively little understanding of where (and to what extent) demand for numbers serving M2M applications may occur. Some of this simply reflects market factors such as uptake, pricing, competition and market positioning. Other factors are connected to technology and implementation choices. These choices will impact the types of connected products and services to be offered, as well as the proportion of the market serviced through mobile networks.

There is a lack of clarity about who or what will use mobile numbers for M2M applications. When combined with the global nature of the industry, consumer mobility, and increasing (though by no means universal) regulatory acceptance of the extraterritorial use of numbers, it is difficult to predict from where numbers may, in practice, be drawn. There are only limited links between the source of allocation and geography of eventual use. So far, the determining factors in the choice of number

[19] s3.3.2, Analysys Mason report for ComReg, *Conservation Measures to Meet Future Demand for Mobile Numbers*, 8th March 2016

[20] The assessed potential total demand predictions (upper limit projections) are based on the proportion of likely total global demand which might be addressed by use of Irish number resources. The lower limit projection is effectively an extrapolation of existing activity by those players interviewed who are presently using Irish resources.

resource include availability, price, industry linkages, and the location of managed service providers[21]. If fundamental technical requirements are met, commercial decisions with regarding the purchase of numbering resources are likely to be strongly influenced by how cheaply and easily such resources can be obtained and how easily they can be deployed across a range of target market sectors and geographies.

In many ways, the uptake of different mobile number resources for M2M usage may have much less to do with conventional numbering attributes but much more to do with the way in which countries make those resources available. Recent legislative proposals in Europe suggest a wider acceptance of extraterritorial use of number resources within the EU. However, the number of regulators at a global level that may allow extraterritorial use of numbers, or be willing to allocate numbering resources to entities other than MNOs and MVNOs, is still very difficult to quantify. The eventual outcome of these matters will help determine how the demand for mobile numbers for M2M services evolves and is satisfied.

Similarly, extraterritorial use of numbering resources in areas geographically distant from those in which they originate may prove problematic from a regulatory perspective. In such a case, providers of M2M services will be influenced in their choice of numbering solutions by the acceptability of those numbers in their key markets. This implies that the demand for Irish numbers could be much stronger in some market sectors than others.

Most indicators predict substantial growth in demand for M2M-related mobile numbers. However, the exact nature of that growth is uncertain. The key message for regulators and other administrators would appear to be one of cautious optimism. The identification and reservation of sufficient dedicated resource to meet maximum expectations should allow for the unfettered growth of M2M activity and the maximum national participation in that activity without undesirable impacts upon consumer-oriented numbering resource, e.g. for normal voice communications.

[21] As an example, from the interviews undertaken with various M2M service providers, InterConnect understands that in one case perceived demand for numbers is already running at considerably more than the annual Irish sales volume for the product line being supported. The logical interpretation of this must be that number resources are being acquired with the intent of deploying them extraterritorially in jurisdictions external to Ireland. At an industry-wide level, the mechanics of deciding from where numbers should be acquired and to where they may be deployed are very largely imponderable at this stage.

At the same time,

1] careful control of allocation and usage of dedicated M2M numbering resources;
2] suitable measures to encourage efficient use and to recover numbers for potential reuse once their original assignment has ceased to apply; and,
3] the holding in reserve of some resource allocations until actual demand is proved,

should help ensure that any surplus resource remains available for other use if M2M-related demand falls short of expectations.

3.3 OTT

Despite the considerable degree of interest in the market development of Over-the-Top (OTT) services, there appears to be little in the way of recent, publicly-accessible data quantifying the number of users of these services in Ireland. In any case, it is dubious as to whether the growth in uptake of OTT services is in itself likely to act as a significant driver in the demand for mobile numbers. Whilst access to OTT services requires the use of smartphones, tablets or other connected devices, each of which may have its own mobile number, at present the prevailing trend is not towards the allocation of numbers to the actual services themselves. As each single connected device is likely to be used to access more than one OTT service, InterConnect considers that the proliferation of such services is unlikely to be directly reflected in the requirement for mobile numbers.

Support for this point of view comes from ComReg's own statistics for mobile subscriptions published in its quarterly market data report for Q4 2016[22]. Between Q4 2014 and Q4 2016, the total number of mobile subscriptions (including mobile broadband and M2M) rose only marginally, from just over 5.8 million to something over 5.9 million, equivalent to an increase of just over 2.5%. At the same time, the total number of mobile subscriptions excluding mobile broadband and M2M followed a similar path. However, the total number of mobile voice and data subscribers using 3G and 4G networks rose from

[22] Irish Communications Market Quarterly Key Data Report Data as of Q4 2016, document reference number 17/15r, available on-line at https://www.comreg.ie/publication-download/irish-communications-market-quarterly-key-data-report-data-q4-2016

just under 4.1 million in Q4 2015 to slightly above 4.3 million in Q4 2016, representing a 6% year-on-year growth compared with a 5.9% year-on-year growth to the end of the preceding quarter[23].

OTT services classified by BEREC as OTT-1 (services complementary to telephone service such as Skype, Viber, etc) may require number resources if accepting incoming calls. OTT-0 services exchanging traffic directly with public fixed and mobile networks will certainly require those resources. The relatively restricted increase in the number of registered mobile subscribers provides no indication of any substantial growth in the adoption and use of OTT-0 mobile services.

In its 2016 report for ComReg on conservation measures in the mobile numbering space[24], Analysys-Mason projected exhaustion of Irish mobile numbers in the 083, 085, 086, 087 and 089 ranges occurring in 2023 if existing historical trends continued to prevail, with this exhaustion point perhaps being brought forward to 2019 should demand experience significant growth driven by allocation to uses such as M2M[25]. With the maximum quantity of numbers in the five-range series established at circa 39 million and ComReg data indicating that some 14.199 million numbers in these ranges remained free for assignment in January 2017, the implication is that net allocation trends up to and including Q4 2016 were continuing to run at a level similar to the lesser of Analysys-Mason's two predictions.

With the implementation of measures to secure efficiency of utilisation by service providers helping to extend exhaustion points rather than bring them closer, at predicted levels of growth present number resources should prove adequate to meet likely demand related to OTT services to 2022 (and beyond) without the need to open-up additional number reserves. It should, however, be borne in mind that if changes in demographics, technologies, market offerings or other factors significantly alter levels of uptake for services require number resources, an entirely possible scenario given the relative newness

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[23] Source: Irish Communications Market Quarterly Key Data Report Data as of Q3 2016, document reference number 16/108(R), available on-line at https://www.comreg.ie/publication-download/quarterly-key-data-report-q3-2016

[24] Analysys Mason report for ComReg *Conservation measures to meet future demand for mobile numbers*, (ComReg reference number16/20a), 8th March 2016. Available on-line at https://www.comreg.ie/publication/report-for-comreg-conservation-measures-to-meet-future-demand-for-mobile-numbers/

[25] Source: Figure 3.15 Analysys Mason report for ComReg *Conservation Measures to Meet Future Demand for Mobile Numbers*, 8th March 2016

of OTT services, this could have a significant effect upon demand for mobile numbers and any concomitant exhaustion point.

4. Identification and Analysis of the Numbering Options

4.1 Introduction

M2M/IoT and OTT services that require numbering resources generally make use of the same numbering resources designated for traditional P2P communication services, unless a specific numbering resource has been designated.

The requirements for numbering resources for M2M/IoT services are significantly different from traditional P2P communication services, because the characteristics of M2M/IoT services include short duration communication and limited or no voice capability. For example, intelligent transport systems, including eCAll and sensor-based traffic analysis systems. These systems may require telephone numbers but do not use them in a "traditional" way.

In some settings, the M2M/IoT ecosystem has an intermediary layer in the value chain (in between the provider of connectivity and the eventual end user). This intermediary layer can act as a provider of services and applications to an eventual end user without providing connectivity. Later in this report, we will see that this "enterprise" is a characteristic of some M2M/IoT implementations that makes numbering policy more complicated. As a result, the requirements for OTT and M2M/IoT numbering policy and Conditions of Use will be different.

OTT services that require telephone numbers can be considered as either a replacement for or an alternative to traditional P2P communication services. As such they could use either geographic or mobile numbers. Unlike M2M/IoT services, the communication profile for OTT services often appears to be very similar to traditional P2P communication services. Those OTT services that do not require telephone numbers or require geographic numbers would not be part of the mobile number environment in Ireland, and are, as a result, not considered further. What we do consider in this report are those types of OTT services that could require mobile numbers and/or MNCs to deliver services to consumers.

OTT-1 services that are considered complimentary to ECS services are in effect closed user groups and would not require separate numbers to make and receive calls within that group. This is known as "on-net." For a P2P communication to originate from OTT-1 service, a telephone number is not technically

required, but is required to comply with CLI regulatory requirements. However, for a P2P communication from the PSTN is to terminate on an OTT-1 service, a telephone number is required. These services, known as outbound and inbound do not have to be offered as a package, and indeed in many cases it is only the outbound calls that occur. Thus, the demand for mobile numbers has not exacerbated the exhaustion of the current ranges.

4.1.1 Consideration of Available Numbering Resources

Numbering resources for public communications services are generally sourced from either a National Numbering Plan or directly from the ITU. In either case, the numbering resources must be used in conformance with conditions or recommendations. The rules for national resources are very different from global numbers. Rules for the use of national resources reflect the legal, regulatory and social requirements of the country concerned. Such rules augment the ITU T Recommendations that initially allocated the country code. The rules for the use of global numbers are governed by ITU T recommendations, with different global numbers having different rules associated with them, and are administered by the Director of the ITU-T's Telecommunications Standards Bureau.

For Ireland's national numbers, these rules are included in the Numbering Conditions (ComReg 15/136) . International, or global, numbers that are managed by the ITU are governed by the rules set out in relevant ITU-T Recommendations[26].

While both M2M/IoT and OTT services could utilise national fixed (or geographic) numbers, the focus of this report is on the use of mobile numbers.

M2M/IoT services are seen as being mobile in nature (for example, associated with telemetry in, or emergency access from, cars, or with wireless connectivity with devices -- including the concept of services being provided on an extra-territorial basis). Such services utilise mobile technology that separates the number from the addressing mechanism (known as the International Mobile Subscriber Identity) that is not present when considering the use of geographic numbers.

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[26] Such as ITU-T Recommendation E.190. "**Principles and responsibilities for the management, assignment and reclamation of E-series international numbering resources" (2006) and ITU-T Recommendation E.164.1 "**Criteria and procedures for the reservation, assignment and reclamation of E.164 country codes and associated identification codes (ICs)" (2008)

OTT services that are likely to require mobile numbering resources would do so for services that are predominantly considered P2P. The General Authorisation conditions associated with geographic numbers already permit the use of geographic numbers for OTT calls. There is considerable information associated with geographic numbers that is known, and used, by various stakeholders, including location, perceived cost, deriving routeing information and supporting access to emergency services.

The current length of mobile subscriber numbers in Ireland is either seven or eight digits. The reason for the difference in the length is that the longer subscriber numbers support access to mobile mailboxes (voicemail). When dialled from overseas, these numbers, utilising the Irish country code and network code, are therefore either 12 or 13 digits long of a possible 15-digit maximum length. The scope for further digits in the number length for M2M/IoT -- in either current mobile ranges or in a separate range -- should be considered.

There are also other issues that could impact which national numbering resources need to be considered. These include:

- existing telephone number ranges that are accessible from overseas;
- existing telephone number ranges that are very similar to the current mobile number ranges; and,
- the EC's proposed European Electronic Communications Code [27] which identifies the need for each Member State to identify a non-geographic number range for M2M/IoT services, to be used on an extra-territorial basis throughtout the Union[28].

Service providers utilising overseas national telephone numbers within Ireland has no direct impact on selecting an appropriate national telephone number range to support M2M/IoT and OTT. However, it may impact the demand for a national range. The impact of the demand comes from using an

[27] Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing the European Electronic Communications Code
https://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/1-2016-590-EN-F1-1.PDF

[28] It should be noted that while the proposed European Electronic Communications Code is focused on the Europe Union, it will have a wider impact.

alternative to national numbering resources. Use of such overseas resources in Ireland should nonetheless require conformance to the Numbering Conditions. The extent to which such ranges are considered with respect to M2M/IoT or OTT services is addressed in the sections below.

As well as reviewing the telephone numbering options, the report will also consider the mobile addressing scheme (International Mobile Subscription Identifier (IMSI). These are subject to a set of rules determined by the ITU. Within the scope of this report, only national IMSI resources will be considered because the assignment and potential reclamation of such resources are addressed in ITU-T Recommendation E.212. Global resources are an alternative to national resources, and directly assigned to the service provider, and therefore possible reducing the demand for national resources have no further impact.

4.2 Identifying Stakeholders and Impacts

To describe and analyse the numbering options that can be considered for M2M/IoT and OTT services, this section details the:

- stakeholders involved,
- possible costs (direct and indirect) of numbering consequences
- the impact of numbers on competition, and
- possible numbering options.

4.2.1 Stakeholders

While there are some stakeholders that are common to M2M/IoT and OTT ecosystems/value chains, there is one very distinct difference[29]. We explore this when we examine the "IoT Users" as defined by BEREC.

4.2.1.1 M2M/IoT Stakeholders

[29] IN BEREC's report on Enabling the Internet of Things (BoR(16 39 – February 2016, Figure 2 IoT value chain) identifies the distinct difference

- **Consumers/End Users**

  This group of stakeholders is at the end of the value chain in the ecosystem. In BEREC's report "Enabling the Internet of Things" (BoR (16) 39), the end user is a consumer of a service provided by / or implemented by integrated IoT systems. An example of this is the car driver whose engine management system is provided as part of the car. The car owner is consuming the service of an IoT user (or enterprise, as defined below)[30].

- **IoT Users**

  Another category within the M2M/IoT ecosystem is the "enterprise." BEREC's report (BoR (16) 39) states that there are entities that *purchase* connectivity for an end user service from service providers or network operators. In effect, the IoT user would be the customer of the connectivity service; and they then provide connectivity, plus a service/application in an onward chain to end users.

  In parallel with the example above, a car manufacturer implementing intelligent vehicle management systems utilised by the manufacturer is an example of an IoT user stakeholder. In this case, there are two, separate consumers of connectivity: the IoT user that is implementing intelligent vehicle management, and the end consumer who may be using connectivity for in-car entertainment or information systems.

- **Service Providers/Operators**

  This category of stakeholders provides the connectivity, and any other needed elements of the network, that are "bundled" together. For services or products that require numbering for M2M/IoT services, they will be allocated numbers by the regulatory authority and will then assign those numbers to their customers.

[30] In BEREC's report on OTT Services (BoR (16 35 – January 2016)) end users are purchasers of access to the Internet and its content, which does not include public electronic communications networks or publicly available Electronic Services.

- **Regulator**

  As part of its statutory responsibilities, the regulator is responsible for the management of numbers in line with the national rules. For ComReg, these are the Conditions of Use and National Legislation.

4.2.1.2 OTT Stakeholders

- **End Users**

  This group of stakeholders is at the end of the value chain in the OTT ecosystem and in BEREC's report on OTT Services (BoR (16 35 – January 2016)) are deemed to purchasers of access to the Internet and its content, but do not provide a public electronic communications networks or publicly available electronic communications services.

- **Service Providers/Operators**

  This category of stakeholders provides the connectivity utilised by end users to communicate with each other or to access content and applications providers. The use of this connectivity has two, distinct use cases.

  The first is as a direct replacement for traditional telecommunication services (also referred to as ECS) that BEREC has categorised as OTT-0. The second is where the connectivity is complimentary to traditional services that BEREC has categorised as OTT-1. As an example, this might be considered as a closed user group for a voice system or instant messaging. Therefore the potential exists for OTT-1 systems to compete with traditional ECS systems. Where the access is to content[31], BEREC categorises this as OTT-2. OTT-2 is also not considered further in this report as it has no numbering requirements.

- **Regulator**

[31] such as e-commerce, video and music streaming

As part of its statutory responsibilities, ComReg is responsible for the management of numbers in line with the national rules. For ComReg, these are the Numbering Conditions and National Legislation.

4.2.2 Potential Costs

Financial costs relate to quantifiable activities and expenditure necessary for the implementation of a numbering strategy. Economic costs are less accurately quantifiable effects of changes and developments that may be defined as relevant to individuals or organisations.

The following summary assumes a general view of issues that will be considered when regulatory approaches to numbering resources are developed.

Direct costs

These types of cost can be identified as arising from the impact of a decision or change that is forced upon a stakeholder. For example, a financial outlay may be directly traceable to the introduction of a new regulatory obligation, the introduction of a new number range or a change to an existing number range, and the management process required to utilise that number range. This might be a direct cost initiated by a decision of the regulator to implement a number change[32]. This change could require network operators and service providers to build new numbers into the OSS, amend and evolve current business processes and require business users to change stationery. Amelioration of such costs might be achieved through planning and advance notification of such a number change.

[32] The 2013 Analysys Mason report for ComReg (13/110) on M2M Numbering estimated that costs to society as a whole are up to EUR1 million for using existing number ranges or for using a new number range with 7-digit subscriber numbers, and less than EUR25 million for a new 10-digit long number range. The costs can be very small if the operators do not need to make various system upgrades. The relative relationship of these costs, amending a number range to introducing a new number range, appear valid. It is simpler to amend a current implemented number than undertake implementation of a new number range.

- **Consumer/End User**

Direct costs associated with the end user are related to the extent to which the number change impacts a user's understanding of, and interaction with, the number that has changed. Direct costs for the end user could include:

- failure to dial the correct digits to complete a call due to misunderstanding the number change,
- restriction of calls because of uncertainty about the cost of a call based on the consumer's understanding of the characteristics of the number,
- reprogramming of Customer Premises Equipment,
- business publications e.g. signage on buildings and vehicles, stationery, etc.

- **IoT end User**

The direct costs that could impact an IoT end User are associated with the use and management of the number as part of its overall life cycle. With regards to the automotive industry example then the costs would include:

- provisioning a means, either in-house or outsourced, to manage the number
- designing and implementing the technology facilities to utilise the number
- establishing commercial arrangements to deliver the service
- changing embedded technology (redesign of units, different connectivity, capability arising from a switching provision introduction, replacement of SIMs, etc.)
- implementing new requirements related to the change of service (anything additional to a hardware change, covering systems and administration)

- **Service Providers/Operators**

Direct costs that could apply to industry, include:

- Numbering Implementation change (includes software and hardware development/replacement, man hours, consultancy, install/maintenance, training, etc.):

  This would include the costs incurred by the operator/service provider to be able to utilise the number change. Examples of such costs could include:

  - deeper digit analysis for longer numbers,
  - capacity on OSS platforms to be able to support the use of longer numbers, and the requirement for greater switch capacity for either new number ranges or longer numbers
  - lost revenue from call failures
  - implementing OSS changes such as for billing systems, customer management systems.
  - implementing new capabilities for new services such as Over the Air (OTA) provisioning
  - provisioning of new hardware required to support the introduction of new ranges. Where such a range is for a new capacity that additional direct costs could also be incurred, e.g. provision and installation of SIMs for M2M/IoT.
  - notification of new ranges overseas
  - labour to undertake the change etc.

- Numbering administration change (mainly manpower, running and changing systems, regulatory support).

  This would include the costs incurred by the service provider/operator for the planning and system development to implement the change. Examples of such costs would include the:

  - capital expenditure,
  - engagement with regulatory authorities to agree on the change,
  - advance publicity to customers to announce the change
  - customer support through the provision of network announcements
  - developing appropriate commercial models to support the services using the numbers etc.

- **Regulator**

Direct costs of introducing a new number range or the need for a number change which could apply to the regulator involves the planning and management of the process. For example, this would include:

- liaison activity with stakeholders,
- legal costs,
- record system changes (new dedicated M2M number ranges will require changes to the number management record system, number request, and allocation processes if number length is different between (or within) ranges)
- issues arising from extra-territorial aspects of solutions choice and implementation
- public awareness communications campaigns: ads in papers, on TV & radio, on-line, etc. (required to educate and inform the public)
- international notification of number change or new range
- amendments to the rules that govern the assignment and use of numbers, i.e. Conditions of Use

Indirect costs

This type of cost may arise for stakeholders in connection with changes made elsewhere, but cannot be said to arise as a direct result of those changes. A change in the nature of consumer communications may result in additional, unexpected costs to the consumer. A consumer might find that there were greater time expenditures or component costs due to a change that did not directly impact them. For example, a number change may cause consumers to stop dialling because the new number is unclear to them -- leading to lost calls to a business. In another example, a consumer may choose not to dial into a new number range because of the perception that dialling the number may incur unexpected costs.

- **Consumers/End users**

Indirect costs for end users could include:

- a business experiencing misdialled calls because of an action was taken by an end user because of their misunderstanding of the number change

- the inability of a consumer's premises equipment to be able to handle the new number; for instance: preventing communications by devices such as personal alarm pendants.

- **IoT End User**

Indirect costs may include:

- selection of the technology (physical SIM v. eSIM) that will determine the ease to switch service providers based on implemented SIM technology – physical SIM exchange v. over-the-air (OTA)
- incompatible SIM implementation restricting competitive choice

- **Network Operators/Service Providers**

Indirect costs include:

- amendment to current Number Portability process to include any new numbering range
- establishment of commercial arrangements to support new processes, e.g. to achieve profitability of new regulatory capabilities such as extraterritorial use of numbers for M2M/IoT that can be characterised as short and frequent, often non-voice, communication.

- **Regulators**

Indirect costs may include:

- the social impact of the number change e.g. (Personal Alarm Pendants for the elderly)
- subsequent number change

4.2.3 Impact of Numbering on Competition

While the promotion and protection of competition have not normally been at the core of numbering regulation goals, ComReg is required to encourage the efficient use and ensure the effective

management of numbering resources in order to achieve its objective of promoting competition[33]. The 'ownership' of numbers for use in electronic communication networks and services is retained by national regulators or global institutions (such as the ITU Recommendations in the numbering sector). This administration of numbering reflects the need to avoid duplication and interference between numbering regimes and the recognition that private control of number regimes could lead to monopolistic exploitation. For a numbering regime to be effective, it must prioritise national requirements while being flexible enough to support international cooperation. Also, numbering policy must find a balance between mutually beneficial cooperation and the ability to support innovation and competition.

Numbering is a key element in the value chains (often referred to as 'value nets' or 'ecosystems' because of their complexity) that will create new products and services for end-users (See demand analysis and Annex C, Section 8). It is probable that changes to numbering policy could affect competition in several sectors of the value chain:

- the definition and allocation of numbers themselves;
- electronic communications networks and services;
- devices that rely on mobile network services for their operation;
- end-user products and services which employ devices requiring M2M/IoT or OTT services.

The growth of this linked complex of markets should provide many opportunities to develop products and services that ultimately provide greater efficiency in the chain of production and strong end-consumer benefits. It is, however, possible that if numbering regulation is not well-judged, scarcity of numbers, or sub-optimal number systems could lead to losses of efficiency and consumer benefits. For instance, using numbers allocated for one service for another service that results in the exhaust of the range, and potentially negatively impacts consumers of that range.

Such possibilities will tend to arise when there is an underlying scarcity of appropriate numbers. This scarcity might be reflected, for example, in the need for some users, including consumers, to suffer a

[33] Section 12(2)(a)(iv) – Communications Regulation Act, 2002 (No. 20 of 2002), as amended.

change in number or the implementation of inefficient numbering regimes. Number scarcity would create adverse effects in several ways:

- failure to be able to assign suitable numbers (or costs in adjusting numbering schemes to avoid this) may lead to the loss of consumer benefit because the end-user products and services are not supplied, or suffer an increase in price;
- loss of the benefits of competition because new entrants or expanding competitors are excluded if they are unable to have access to appropriate numbers;
- if requests for numbers can only be met by re-adjustments of existing number assignment be met, requirements to implement number changes that create costs for consumers, e.g. business users requiring stationary changes, signage etc. to change.

Economic efficiency will be increased by the availability of many (competing) substitutes for a product or service. Numbers have no production costs, and it is advantageous to have efficient, freely-available numbering regimes that will ensure that there are minimal barriers to entry to the various downstream service markets. No possibility for downstream consumer benefits should be lost because of numbering difficulties. Indeed, activities using M2M/IoT and OTT-0 services are amongst the most dynamic in the economy and other productive and innovative products and services may be based on them. To the extent that such services use numbers, then the impact of the availability of numbers could, therefore, spread throughout the national economy.

Competition issues are most likely to appear when number ranges to be used are becoming congested. If there is difficulty in providing numbers for new services supplied by entrants to downstream markets, then existing possession of suitable numbers may confer some degree of market power on ‘incumbents.' Crowded number ranges, therefore, pose two problems:

- the possibility that number may not be available for new uses and that the consumer benefits from these uses may be lost; and
- the possibility that competition problems may arise as those already allocated numbers have an advantage over new entrants. This is especially likely as numbering regimes may show network effects – making large and integrated number regimes more attractive than smaller ones.

The impact of number scarcity would be two-fold, causing productive activities to be foregone and the intensity of competition to be reduced. This chilling of competition may arise 'horizontally' at each of stage of the value chain, or 'vertically' as providers in these markets seek to integrate up or down the value chain. Regulators should act to ensure that incumbent players do not seek advantage where numbers have become 'bottlenecks' within the value chain. This aim can be achieved by regulation, especially where there are cooperative elements to the design of numbering regimes. But the introduction of some further elements of competition may also have a role to play.

Numbering issues already create some impediments to beneficial competition and therefore the possibility of market power or inefficiency. The clearest case of this is where there are significant 'switching (of supplier) costs.' In mobile P2P communications markets, which would include OTT-0 services, these costs may be suffered by final consumers who would have to be assigned a different number should they wish to change communications supplier (for example in changing stationary or informing contacts of the change). The typical regulatory response is to impose requirements of number portability. A number also often contains a certain amount of information – for example, geographical location or price – which may be lost if number patterns must change because of shortages. Number portability is generally considered to have costs lower than the benefits of switching for consumers. With the growth of M2M/IoT traffic, however, consumer switching cost will be less significant, because the numbers used are not visible to the end-consumer. Another issue may arise, however, in that the problem may shift to switching by service providers of network supplier. This may require, for example, physical access to SIM cards and corresponding switching costs. Remote control of SIM cards may prove to be a solution, but it may in some cases it may be necessary to consider Service Provider Switching.

Competition issues have so far played a relatively limited role in the implementation of numbering in electronic communications; but the growth of M2M/IoT/OTT traffic has not – yet - placed the kind of pressures on numbering that might bring about shortages of numbers and consequent questions for numbering and competition policy. As growth in M2M/IoT/OTT traffic accelerates, there may also be opportunities to enable this growth to be accompanied by increased competition in service and end-user markets. It is likely that M2M/IoT service providers require access to an efficient numbering system but would prefer a regime under which numbers could be allocated to them with Conditions of Use that are as flexible as possible so that they may make, as freely as possible, their own decisions as to the commitments that they will make in assigning numbers to their activities and customers. Numbers would be available such that no otherwise desirable service or activity should be excluded by number

availability or numbering regulation. By opening up new number ranges, or by adopting numbers with more digits, sufficient numbers could be provided to support a very large demand. OTT-0 services that have a justifiable requirement for mobile numbering resources as P2P communication services would utilise existing mobile number ranges.

From the point of view of the national economy, there may be opportunities to make numbers available widely, including to overseas users, without this interfering with the requirements of a national numbering system for P2P traffic which does require stringent Conditions of Use. These potentialities would suggest that numbers should be made available in ways that can absorb very large demands and would require little supporting regulation and avoid unnecessary changes to existing ranges with little or no benefit. For example, there may be no need for end-user number portability. Regulation would not be a barrier to entry to the service provider or end-user markets.

Very large demand could then be accommodated in a separate numbering resource where Conditions of Use are appropriately specified, and there is more opportunity for greater control of number management by network service providers and for competitive market behaviour. ITU Global Number ranges could also be used in this way. There would also be the possibility of market-related charging for such allocations, yielding financial benefits for the national economy. Existing and future P2P communication services would operate under different regulatory frameworks, though pressure on present number ranges would be reduced.

P2P services need to be numbered under certain Conditions of Use (perhaps to prevent scope for anti-competitive behaviour e.g. via restricting portability) while M2M services will require alternative Conditions of Use that provide protection for consumers because consumers are never directly involved.. Some OTT services may fall between these two requirements for regulation, with some potential risk of damage to competition and/or consumers. For example, numbering issues in respect of OTT services that have the characteristics of P2P (i.e. OTT-0) also attract regulatory attention because of the possibility of anti-competitive behaviour involved in moves to integrate across service platforms. A risk adverse path would identify OTT-0 services and ensure that they continue to be treated as in the present numbering regime. At the same time, the establishment of new numbering regimes for M2M services would mean that there would be less pressure on numbers in the ranges currently used by OTT-0 services..

The links between numbering policy and market competitiveness are currently not strong. This, however, could change should scarcities occur in the use of present number ranges. Should such scarcities arise, there is the possibility of the loss of significant benefits through the value chain and ultimately to end-use consumers. The extent and impact of these losses would be accentuated by the adverse effects that scarcities could have on competition. The maximisation of benefits for the national economy will not take place if numbers become scarce, numbering regimes are inefficient, and barriers to entry for new products and services are not as low as possible. This would avoid creating the possibility that numbering resources already held by 'incumbents' could yield some market power, resulting in competition in downstream products and services being chilled. The regulatory response therefore, requires the correct balance of cooperative and competitive elements. One possibility is the creation of separate number ranges with specific conditions of use for P2P communication services and M2M/IoT services.

4.3 Numbering Options

This report considers three numbering options within the context outlined above. The options outlined in this report are the optimal proposals for:

- being the simplest options for ComReg to implement with limited disruption while achieving the goals of innovation and competition
- providing an evolutionary path should demand require more mobile numbers to be made available.

The three options can be categorised as follows:

- Option 1 Allocation from current mobile Numbering Ranges
- Option 2 Implement new Alternative Numbering Range
    - Option 2a New Number Range 08x + 7 digits
    - Option 2b New Number Range 08x + 8 digits
    - Option 2c New Number Range 08x + 9 digits
    - Option 2d New Number Range 08x + 10 digits
- Option 3 Use of a Global (International) Number

N.B.: Global Numbers are an option for Service Providers and their use requires compliance with national regulations in the jurisdictions in which they are deployed

These options will be considered for M2M/IoT and OTT respectively.

International, or Global Numbers, are also considered as possible options for M2M/IoT and OTT. This is done under the current assignment rules -- recognising that such rules are the purview of the ITU and its membership.

However, National Regulatory Authorities, such as ComReg, have more flexibility and control than the ITU in number management. While ComReg (and other National Regulatory Authorities) can use their power in supporting consumer choice by mandating that national numbering resources are brought into service, the ITU has no such authority for mandating the deployment of global numbers. Some of the mechanisms needed to deploy new numbering resources will require changes to the Conditions of Use. These changes will be considered later in this report.

ComReg manages national numbering resources under the Numbering Conditions. Each condition in the Numbering Conditions falls into one of two categories. It is either a condition attached to a right of use (a "RoU Condition") or a condition attached to the General Authorisation (a "GA Condition"):

- "RoU Conditions" are attached to rights of use for numbers granted by ComReg to individual undertakings.

- "GA Conditions" are attached to the General Authorisation and apply equally to all authorised undertakings

The Numbering Conditions identify some conditions that apply to national numbers that have been allocated. General Authorisation conditions include:

- Number Portability,
- Calling Line Identity
- Number Changes

Rights of use conditions include:

- timeline to introduce new numbers,
- information to be retained about the numbers allocated and
- for specific classes of numbers, the rules governing their structure and commercial environment is also considered.

These points need to be considered when looking at potential national numbering options for M2M/IoT and OTT.

The draft European Electronic Communications Code (EECC)[34] seeks to have national regulators identify a non-geographic range for purposes other than for interpersonal communications and for use by undertakings other than providers of electronic communication networks or services. In supporting the aspirations of the EECC to promote these services within Europe, ComReg will need to ensure that rights of use and general conditions exist to enable the use of a national numbering range in a manner that allows for innovation, promotes competition and addresses the requirements of the draft EECC as it stands at the time of this report.

Each of the three possible numbering options is described further in Sections 4.3.1, 4.3.2 and 4.3.3.

4.3.1 Option 1: Use of Current Mobile Number Ranges

ComReg's Numbering Conditions designates mobile numbers as being 083, 085, 086, 087 and 089 and numbers have been allocated from these ranges as shown in Table 2. Not all numbers in these ranges are available as parts of the ranges have been reserved:

a) To allow for expansion,
b) for mailbox access, or
c) to avoid potential misdialling.

[34] Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing the European Electronic Communications Code COM (2016) 590 final 2016/0288 (COD)

The vast majority of these numbers are used for consumer mobile and have general Conditions of Use associated with them. Within the Numbering Conditions document, ComReg states the general authorisation condition and the general conditions for specific classes of numbers (or numbering ranges).

The specific Conditions of Use for mobile numbers states:

a) the structure of a mobile number (08X + 7 digit)
b) the use of the digit 5 in front of the 7-digit subscriber number for use to access mailboxes.

The definitions within the Numbering Conditions specify the entities that can receive numbering allocations. These are Mobile Network Operators (MNO), who own and operate an infrastructure, and a Mobile Virtual Network Operator, who must, through a contractual agreement with an Irish MNO, have access to a mobile network to provide a mobile service.

The current mobile number ranges as outlined above are for the most part P2P Communications. There are some parts of these ranges that have been used for M2M/IoT. Whether that is sustainable in the longer term is a commercial decision for those service providers utilising these ranges. Such a commercial decision not only relates to the termination rates that would apply, but also to the costs of complying with the Numbering Conditions, such as number portability.

Those OTT services that fall into the category of replacement P2P communication services (OTT-0) have so far not created a significant demand for national mobile numbers. They are predominantly associated with mobile telephones and therefore are included here. Fixed number requirements are not addressed further.

Previous studies have looked at the future demand for 08x numbers and mechanisms to manage these resources to extend their availability. The growth of OTT services has not seen a similar increase in demand for mobile numbers and would indicate that OTT services are not having an impact on the supply of mobile numbering resources.

A number of measures have been previously identified (e. g. conservation measures to meet future demand for mobile numbers (March 2016)) that service providers can implement to achieve better utilisation of existing allocations. The measures that have been identified include recycling numbers, and repatriating of numbers to original range holder when services are ceased. A range of possible measures exist for ComReg to take that can extend the availability of 08x mobile numbers including recovery of existing unused blocks, allocating further numbers only after SPs have set utilisation rate, and ending the de-facto mapping of 08x network access code to SP. These measures are both appropriate and proportionate and are recognised as good management techniques for number management.

Were there to be demand for additional 08x resources, over and above the current 08x mobile ranges for P2P mobile communication services, then 082 and 084 could be used in the future. 088 has no current allocations from within it (although it has previously been used for TACS[35], and subsequently withdrawn).
Achieving greater utilisation of the existing 08x ranges should be the first step to meeting future demand for such services. This approach represents good number management. Only when the existing consumer mobile number range achieves a utilisation of 85% should new number ranges be considered.

The ranges 080 and 081 should be avoided for mobile services unless demand indicates otherwise. In 081, a legacy range 0818 exists for universal access that has evolved into national rate phone calls. This has been in existence for a considerable time. To use other ranges in the 081x range for P2P mobile communication services could create confusion with consumers, especially in their understanding what the numbers are for, and what charges might apply. In addition, the potential costs for operators of having different commercial arrangements in the same range, as well as dealing with varied number lengths, make other ranges in 081x a poor choice for P2P mobile communication services. 080 should similarly be avoided being brought into service because of the potential clash with the UK's free phone numbers of 0800 and 0808 as well as the potential confusion with Universal International Freephone numbers.

[35] Total Access Communication System

Table 2 Ireland Mobile Number Ranges and Allocation

08X +7 digit (ranges currently in use)	Total amount of numbers assigned to operators	Total amount of numbers reserved	Total amount of numbers free for assignment	Notes
				•
083	4,400,000	2,000,000	3,600,000	• 083 (9)xx xxxx (990,000 numbers) reserved for expansion • 083 (5)xx xxxx (1,000,000 numbers) reserved for mailbox access. 8-digit mobile mailbox numbers created by placing the digit '5' in front of the 7-digit subscriber number • 083 999 xxxx (10,000 numbers) reserved to avoid potential misdialling of 999 emergency number
085	3,700,000	3,000,000	3,300,000	• 085 (9)xx xxxx (990,000 numbers) reserved for expansion • 085 (5)xx xxxx (1,000,000 numbers) reserved for mailbox access. 8-digit mobile mailbox numbers created by placing the digit '5' in front of the 7-digit subscriber number • 085 999 xxxx (10,000 numbers) reserved to avoid potential misdialling of 999 emergency number • 085 (0)xx xxxx (1,000,000 numbers) reserved for potential future use for international access to shared cost numbers .
086	5,990,000	2,000,000	2,010,000	• 086 (9)xx xxxx (990,000 numbers) reserved for expansion • 086 (5)xx xxxx (1,000,000 numbers) reserved for mailbox access. 8-digit mobile mailbox numbers created by placing the digit '5' in front of the 7-digit subscriber number • 086 999 xxxx (10,000 numbers) reserved to avoid potential misdialling of 999 emergency number
087	6,791,000	2,010,000	1,199,000	• 087 (8)xx xxxx (1,000,000 numbers) reserved for expansion. • 087 (5)xx xxxx (1,000,000 numbers) reserved for mailbox access. 8-digit mobile mailbox numbers created by placing the digit '5' in front of the 7-digit subscriber number • 087 999 xxxx (10,000 numbers) reserved to avoid potential misdialling of 999 emergency number
089	2,900,000	3,010,000	4,090,000	• 089 (8)xx xxxx (1,000,000 numbers) reserved for expansion. • 089 (5)xx xxxx (1,000,000 numbers) reserved for mailbox access. 8-digit mobile mailbox numbers created by placing the digit '5' in front of the 7-digit subscriber number • 089 999 xxxx (10, 000 numbers) reserved to avoid potential misdialling of 999 emergency number • 089 (0)xx xxxx (1,000,000 numbers) reserved for potential future use for international access to shared cost numbers.

4.3.2 Option 2: Use of New Number Range

A potential new telephone numbering range for M2M/IoT would be 088. The Numbering Conditions and General Authorisations will need to be revised to be supportive of the use of this new numbering resource.

There are three options for 088.

- Option 2a: identify and open a new number range in 08x + 7 digits
- Option 2b: identify and open a new number range in 08x + 8 digits
- Option 2c: identify and open a new number range in 08x + 9 digits
- Option 2d: identify and open a new number range in 08x + 10 digits

There are variations on Option 2d, below, which utilise the full length of a number, namely 15 digits, as specified in ITU-T Recommendation E.164 "The International Public Telecommunication Numbering Plan."

4.3.3 Option 3: Use of a Global Number

These numbers are assigned to service providers by the ITU and are in the format of CCC xx(y(y)), where the CCC represents the country code, currently either +882 and +883, and a subsequent 2, 3 or 4 digit identifier allocated directly to a service provider based on criteria in ITU-T Recommendation E164.1.[36] At the time of this report, ITU-T's lead technical group on numbering is investigating the possible use of +878 for M2M/IoT.

Numbers that are assigned directly to service providers by the ITU require an assessment against specific criteria. These criteria include:

- the applicant undertaking must conform to national laws and regulations in countries where these global numbers are deployed; and,

[36] ITU-T Recommendation E.164.1 "Criteria and procedures for the reservation, assignment and reclamation of E.164 country codes and associated identification codes (ICs)".

- the numbers not being used to replace PSTN services.

The existence of such rules, and their impact on the use of global resources, is discussed in the respective sections on M2M/IoT (section 4.4) and OTT (section 4.5).

4.4 Options for M2M/IoT

4.4.1 Option 1: Use of Current Number Ranges

In studying the use of existing number ranges for M2M/IoT, and noting the Conditions of Use that exist with respect to the current ranges, both the suitability of the range and the potential impact of demand for the resources need to be considered.

While the requirement for numbers could be met from existing mobile number ranges, given the likely demand, would such an approach be sustainable? And if not, what would the consequence be for the various stakeholders? A further issue is the relevance of the rights of use of the current number ranges for providers of M2M/IoT connectivity. While some service providers are using existing mobile number ranges for M2M/IoT, having a number range with potentially different uses, different number lengths, and different Conditions of Use becomes very confusing for all stakeholders.

The way M2M/IoT services are likely to be deployed, to an enterprise rather than to individual consumers, makes the use of current national mobile numbering resources difficult. The existing telephone numbers have rights of use and general conditions attached to them, such as number portability. These may not be relevant in M2M/IoT settings. That is not to say that an enterprise should not be able to benefit from a choice of provider. However, the enterprise is not the M2M/IoT end user, and therefore a different mechanism, other than number portability, is required -- for example, service provider switching.

For end users, having significant demand exhaust the current number ranges could result in a number change (e.g. increase the length of the numbers). Such an approach would also have an impact on both service providers and network operators. For end users of consumer mobile numbers, assigning such numbers for M2M/IoT -- even at the lower end of the 'upper limit' demand

forecast, i.e. 21 million required numbers -- would certainly place consumer mobile numbers in a situation of possible exhaust. It might also require other actions, either extending the number length, or introducing a new range. Such use should also consider the appropriateness of the Conditions of Use of consumer mobile numbers for M2M/IoT. Setting aside the impact of demand, consideration of the Conditions of Use and eligibility requirements for assignment should also be factored into a decision as to whether to establish a new range for M2M/IoT.

Given the very different nature of the use of M2M/IoT from current services, allocating numbers from the currently available resources to M2M/IoT, with existing Conditions of Use, has several negative connotations.

First, were there to be a significant demand by M2M/IoT service providers for these resources then the possibility of number exhaustion cannot be ignored. In such a circumstance, the impact on consumers of undertaking a number change that extended the length of numbers (to increase capacity), driven by alternative services, may cause confusion without yielding any benefit.

Similarly, if M2M/IoT service providers were allocated numbers from existing resources, they could be subject to Conditions of Use reflective of P2P communication services rather than M2M/IoT communications. This could include conditions such as traditional number portability or unnecessary costs in establishing processes. ComReg could incur costs in time and effort to be able to address these types of issues brought about by diverse uses within the same numbering resource. This would result in confusion regarding compliance with the current Conditions of Use and lack of transparency within a given number range.

While service providers could potentially access the current number ranges, the Conditions of Use of the current number ranges could impose unnecessary requirements upon M2M/IoT Users and service providers. Alternatively, the regulator could assign numbers from current number ranges for M2M/IoT with different Conditions of Use to reflect the requirements of M2M/IoT services. As an example: remove the requirement for number portability and in its place, require Service providers to support M2M/IoT users to be able to switch their supplier.

The intention, expressed in the EC's proposed European Electronic Communications Code, to allow extra-territorial use of numbers could also have commercial consequences. If usage for M2M/IoT

was allowed from current ranges, an alternative requirement indicated in the draft European Electronic Communications Code for records to be kept in a database over and above the information currently required in the Conditions of Use. Utilising of existing number ranges that would be inserted into the database could cause confusion. For service providers, negotiating different commercial rates for services that are, in effect, low connectivity, and that use a numbering range with retail roaming rates, could have several impacts. In addition to the commercial usefulness of the range to be used overseas, there would also be the potential of having one range support greater complexity in routeing and billing and inhibit its use for innovative services from that range.

One possible further consequence of a future requirement to open up a new numbering range for M2M/IoT is that it might create barriers of varying degrees for stakeholders. For service providers, this could include issues of opening up a new numbering range overseas, or of agreeing on the commercial rates for that new range. Utilising a new range from within 08x for M2M/IoT services would allow exploitation of knowledge of this range overseas and would facilitate its introduction. This could be supported by the existing industry process present within GSMA. Alternatively, opening a totally new range has no such precedence, and is therefore much harder to achieve as there is no transfer of knowledge. Other issues could emerge if a new range were introduced with different rights of use, perhaps recognising the requirement for switching rather than number portability. In these cases, the ability of enterprises to take advantage of the competitive benefits of the new range could be called into question. Furthermore, the ability of service providers to compete fairly and equally could also be called into question.

A further point to note, based on the perceived demand for mobile numbers, is that the current level of utilisation and modality of on-going management makes this approach unsustainable for the future. Previous studies that ComReg have had carried out (Analyses Mason) identified actions that could be undertaken by both ComReg and mobile operators to achieve greater utilisation from the current ranges. The impact of these actions will, over time, do much to ensure that number exhaust in current mobile ranges can be avoided. Effort would be needed to either better manage the current numbering range in a shorter time frame than is currently envisioned, or force the introduction of new number ranges for all stakeholders. This situation would be exacerbated were the demand projected to exist for M2M/IoT be realised and be met from current consumer mobile ranges.

As a result, current numbering ranges for consumer mobile services are not considered further for M2M/IoT.

Stakeholder	Cost	Benefit
Consumer	• Potential number change if demand outstrips current numbering range • Potential confusion with other current numbering allocations for telephony	• No change
IoT User	• Current rights of use might be restrictive for innovative use e.g. extra-territorial use	• Numbers are in service and are easily accessible
Service Providers/Operators	• Demand could force number change • Conditions of Use have unnecessary requirements, such as NP	• Numbers can already be allocated
Regulators	• Demand driving requirements for additional numbers • Managing different regulatory requirements within the same ranges	• Business as usual

Table 3 M2M Option 1 Use of Current Number Ranges

4.4.2 Option 2: Use of New Number Ranges

This section describes the various new national mobile telephone numbering resources that could be selected and deployed for M2M/IoT services. Given the nature of M2M/IoT implementations, where the focus is on extra-territorial use (supported by roaming, based on mobile technology), it makes sense to use available, and similar numbering ranges to those currently used for consumer mobile services. Using similar, but distinct, ranges will allow ComReg to exploit the implementation of the current mobile ranges, by utilising and exploiting the operational support systems of service providers that are focussed on 08x for mobile, and to specify specific Conditions of Use for the range. Utilising a new range from 08x for a service that will be used overseas on an extra-territorial basis makes use of the characteristics associated with the existing mobile ranges, or at least a range that could exploit such characteristics. As much of the 08x range is designated for mobile services and is recognised as such, the use is independent of fixed geographic location and thus has the

potential to support Irish based M2M service providers serving National, European and International markets. Such an approach to using 08x allows for easier opening up of additional numbers, and to facilitate call originators to determining routeing and charging. Other ranges have been considered[37], but at that time[38] extra-territorial use was not a required characteristic, and were that range to be considered in this instance, would be seen as not being a mobile range.

A number of options are potentially available. In addition to a possible new number range (and new Conditions of Use), another consideration is the length of the numbers. The decision of the number length needs to minimise the disruption to both ComReg - in having to administer the range in the face of demand and potentially having to provide an additional resource in the future - and to operators and service providers in having to implement it. Consumers, not having a direct interest in the allocation of the numbers, should not be impacted by the number block or length of numbers that are chosen for M2M communication.

ComReg should consider using the 088 telephone number range. In utilising this range and, in support of competition and innovation, the Conditions of Use that should be considered should include service provider switching and extra-territorial use. Access to emergency services should only be a requirement by M2M/IoT numbering resources when access is required as part of the M2M/IoT service offering. For example, the requirement to implement eCall from March 2018 (Regulation (EU) 2015/78 of the European Parliament) will place a demand upon national numbering resource. In the event of an accident, an eCall occurs between the car and Public Safety Access Point, designated by the regulator as the undertaking to provide access to emergency services, and supports a limited voice capability. While the initial call is originated using an emergency number, by dialing an emergency number (either 112 or 999), the requirement for an E.164 number is to permit the PSAP to initiate a call back to the vehicle.

Conditions of Use need to be included that limited voice communication is only to be supported. Calls to and from the PSTN should not be supported in general, and only in those cases of an emergency as part of the M2M/IoT service offering. In support of the PSAP being able to initiate a call

[37] Report of Numbering for Machine to Machine Communications (ComReg 13/33 March 2013)

[38] Numbering for Machine to Machine Communications: Publication of responses to ComReg Consultation Document 13/33 and notes from bi-lateral meetings (ComReg 13/66 R November 2013)

back then there will be a need for the number associated with the vehicle to be included as a calling line identifier in the original call, which should also be reflected in the Conditions of Use. Also, any new Conditions of Use that are applied should also consider further requirements based on the final European Electronic Communications Code.

While the potential demand for mobile numbers is much discussed, the M2M/IoT marketplace is still relatively new; as a result, it is difficult to talk about demand with any certainty. This is reflected in the approach of the regulatory environment for numbering resources within the draft European Electronic Communications Code, which indicates the broad approach to identifiers required to support the development of the M2M/IoT marketplace.

The option to utilise new number ranges for M2M/IoT services allows for the specific issues associated with those services to be accommodated cleanly from day one. Issues surrounding specific Conditions of Use, such as number portability, number length, and potential difficulty in easily regulating the use of numbers are removed.

Four possible new number lengths in any new ranges have been identified for this report, namely

- 08x + 7
- 08x + 8
- 08x + 9
- 08x + 10

For consumers and end users, who would rarely know about the new M2M/IoT numbers, there would be no confusion with existing mobile numbers for traditional telecommunications. This would still be true if a different number length were introduced.

For service providers, the key benefit is to have numbers which are clearly distinguished as being for M2M/IoT with specific Conditions of Use, including the ability to switch service providers. Having a distinct number range would allow for commercial terms specific to M2M/IoT to be negotiated. In discussions with industry stakeholders, two of the consensus characteristics of M2M/IoT communication are low data rates with potentially high levels of signalling. Combined with the concept of extra-territorial use, this creates costs for various network providers -- with little or no

supporting income. It is likely that different commercial models will emerge. Having different commercial models on separate ranges rather than amongst the existing ranges provides additional benefits. For example new and alternative number range avoids customer confusion with other P2P communication services, allows Service Providers to have a distinct commercial model and regulatory environment, and allows the regulator to impose distinct requirements upon the use of numbers. These might include reflecting different Conditions of Use for different commercial models.

The Conditions of Use associated with the new range need to include various aspects:

- the numbers need to be brought into service within six months of being allocated; otherwise, ComReg will recover the allocation;
- numbers allocated for specific use, such as for eCall may need to have special Conditions of Use to ensure efficient utilisation of the range (for example, managing the number when the car is no longer used). Additional numbers would only be allocated when the service provider has achieved a level of utilisation, suggested as being 65%. The increase in the utilisation figure reflects the fact that M2M Service Providers' systems should be more efficient when utilising numbers compared to MNOs' systems that utilise numbers for P2P communications. The utilisation level is intended to ensure that the service providers make best use of the resources that they have assigned to them.

In addition to the conditions in which the numbers are assigned it is also recommended that Service Providers are required to manage the allocation of numbers that they are assigned from any new number range that is introduced. As they are not known to end users, the numbers assigned to M2M/IoT can be recycled on a shorter time scale (e.g. 3 to 6 months) as the numbers will not be publicly visible and thus require less quarantine than numbers used for consumer services. This will potentially allow a smaller block to achieve more utilisation

Some advantages of utilising a new number range include the ability for ComReg to set Conditions of Use that promote competition, meet the emerging European Requirements, and allow for innovation without having an unnecessary impact on other stakeholders. ComReg can consider the Conditions of Use that would allow the take-up of national numbers to facilitate the introduction of M2M/IoT while simultaneously exploiting international connectivity.

Which of the new numbering lengths in any new numbering ranges should be considered is a further issue that would be driven by the extent of the demand. ComReg's approach to the assignment of numbers could be to allow for the evolution of the number length from what is currently used today for traditional telecommunications, to a length that is longer, potentially utilising the full number length permitted by ITU-T E.164.

While the implementation of the current ranges allow for numbers to be 12 or 13 digits long, currently +353 8X XXX XXXX (12 digits) +353 8X 5 XXX XXXX (13 digits) (to support the concept of accessing mobile mailboxes) extending the number length beyond these digits will incur costs to service providers. Service providers should currently be capable of supporting mobile numbers that are 13 digits long (including the country code) as this is the length of numbers required to access mobile mailboxes. International service providers should be capable of routeing on 15 digits, and information seen by InterConnect would indicate that this is likely in practice.

What remains unanswered is whether it would be beneficial to allocate numbers of 13 digits rather than 12 digits. The benefit of allocating 13 digits would be that, should a subsequent number change be required, it would be significantly in the future. If the change were eventually to be required, it could be planned for in an appropriate time scale, and also avoid disruption and costs to operators and service providers compared to a possible intermediate number change were 13 digits to be chosen.

The limitation of a telephone number is determined by ITU-T Recommendation E.164 and that sets the maximum length of a telephone number to 15 digits. This length includes the country code. Theoretically, for Ireland, with a country code of 3 digits, the remaining 12 digits are available for use. The current maximum subscriber number length in Ireland's numbering plan is eight digits and this is used to support access to mobile mailboxes in the currently allocated 08x mobile ranges.

Other national regulators who have implemented dedicated telephone numbering resources for M2M/IoT have allocated numbers that make full use of the 15-digit telephone number length. This is an approach that has been supported by the recommendations from ECC/CEPT that "the number length in the new number range……should be as long as possible" (ECC Recommendation (11/03) Numbering and Addressing for Machine to Machine (M2M) Communications). Whether a number

length of greater than eight digits could be utilised in Ireland would also need to take account of the other uses to which numbers are used, for example, billing systems.

In ComReg's response to the consultation (Numbering for Machine to Machine Communications – Response to Consultation (ComReg 13/109) November 2013), and in its interviews with operators in response to the consultation (Numbering for Machine to Machine Communications: Publication of responses to ComReg Consultation Document 13/33 & notes of bilateral meetings), there was no consensus about a number length, should a range be introduced. In fact, in several cases, limitations existed that restricted the potential number length that could be implemented. However, discussions with Irish mobile operators as part of this report would indicate that, for all but one operator, such limitations of the number length no longer exist. Also, operators of international telecommunications gateways that responded have confirmed that 15 digit numbers can be handled for routeing.

One approach could be to allocate numbers in a new range at the maximum length possible (15 digits), and for those operators that cannot use the maximum length at this time, that 13 digits be allowed. This would be combined with a timeline given to those operators who do not initially use the maximum length to later migrate to the full number length. This approach allows those who want to utilise the full number the ability to do so immediately, while also allowing a maximum number of operators to be able to take advantage of a new numbering resource. However, this approach would require the use of mixed subscriber lengths within the same range and may cause some issues with call routing depending on the level of number analysis by individual carriers.

Some service providers are already using current allocations from existing mobile ranges for M2M/IoT. As part of the introduction of a new range, any current allocation from existing number ranges that have been made for M2M could have a target date set by which they could migrate. However, this should be left to a commercial decision to be taken by the service provider. Having a distinct range with a different length of number and potentially commercial arrangements could incentivise that migration.

The conditions and rights of use of the number should, in addition to detailing the length of the number, ensure that the range chosen has the capability to expand should there be sufficient

demand in the future. To support this approach, and to ensure good utilisation of the numbers, service providers must demonstrate the need for further allocation of numbers.

Based on the needs of the service provider, consideration should be given to the size of the number allocation that is made. Depending upon the need of the service provider this could be anywhere between 100,000 and 1,000,000 numbers. This is good number management and allows for flexibility to meet the potential variation in the demands of service providers.

Other issues that are required to be covered by the Conditions of Use is the support of extra-territorial use of numbers that is being seen in many implementations and is proposed in the draft European Electronic Communications Code. The extent to which other countries allow for extra-territorial use of numbers varies; there is no emerging consistent approach to the issue. The tendency is to permit extra-territorial use of numbers for M2M/IoT. This is a different approach than the use made of mobile numbers for P2P communication services today and, therefore, should have an explicit condition of use to address these rights.

For ComReg, the introduction of a new numbering range, potentially with a different digit length could impact their internal management systems. This would govern which potential option might be selected for a new range.

Stakeholder	Cost	Benefit
End User	• None	• No impact due to number exhaust • Removal of potential confusion from use of existing number ranges
IoT User	• Selection and implementation of technology to support M2M/IoT • Ensuring technology allows for Service Provider Switching • Deploying numbers in support of commercial operations	• Specific Conditions of Use to ensure competition • Capability of using a number range extra-territorially overseas
Service Provider/Operator	• Developing systems to accommodate potential new number lengths	• Specific Conditions of Use that support extra-territorial use

	• Ensuring capability to provide Service Provider Portability • Demonstrating capability to manage numbering resources to meet possible assignment rules	• Distinct range caters better for different commercials / tariff models
ComReg	• Develop the Numbering Conditions of Use to support specific Conditions of Use for M2M/IoT • Managing the availability of numbers for the minimum cost to stakeholders	• Actively use numbering to support innovation and competition • Minimise disruption to stakeholders • Avoid restrictive approaches to commercial operations by using current Conditions of Use

Table 4 M2M Option 2 Cost Benefit of New Number Ranges

4.4.3 Option 3: Use of a Global Number

In addition to considering possible national numbering approaches, consideration should also be given to allowing the use of international or global numbers allocated by the ITU. In so far as current global ranges are available and open, utilisation of such resources by IoT users is a possible alternative. In the future, the use of specific global numbers to support M2M/IoT services could be introduced. The use of either of these global resources does offer some benefits to the service providers that make use of them. For M2M/IoT this would mean that a single resource can be deployed globally for international enterprises (subject to the agreement of the local regulatory authorities[39]). Additional benefits accrue for national regulatory authorities in that the use of these global numbers provides an alternative to national numbers. Therefore, given the perceived demand for M2M/IoT, this option potentially avoids depletion of national numbering resources. This is especially true if such demand is compounded by extra-territorial use.

Any use of global numbers within Ireland should require the undertaking to comply with the general authorisation that applies to ECS service providers using national numbering resources.

[39] ITU-T Recommendation E.190. "**Principles and responsibilities for the management, assignment and reclamation of E-series international numbering resources" (2006) and ITU-T Recommendation E.164.1 "**Criteria and procedures for the reservation, assignment and reclamation of E.164 country codes and associated identification codes (ICs)" (2008)

Utilisation of a global number for M2M/IoT services would have a greater impact were current national consumer mobile numbering ranges designated to include an allocation to M2M/IoT services. However, this would require Service Providers meeting the allocation criteria of the ITU to receive such numbering resources. The impact of global numbering resources on a separate national M2M/IoT numbering range is less dramatic than on M2M/IoT being supported by existing consumer mobile numbers, as the separate national numbering range can meet the higher end of the 'upper limit' demand forecast of 70 million numbers, especially with a longer number length than is currently available for existing consumer mobile number ranges.

Global numbers are allocated by the ITU and assigned directly to a service provider in accordance with criteria specified in ITU-T Recommendation E.164.1. Included in the criteria are requirements that:

- the numbers must not be used in one country or under one integrated numbering plan (to avoid bypassing national numbering regulation),
- that the service for which they are to be used does not duplicate voice services
- the numbers are not portable, and,
- statement of compliance by the assignee with national regulations.

For a service provider, therefore, to be able to use such numbers in Ireland, then they would need, for example, to be in service in other countries and to support service provider switching. However, ensuring access to these global numbers has so far proved challenging. Not all global numbers have been successful in having access negotiated in a national context. However, there has been limited success, and this success can possibly be leveraged in the future.

One of the barriers to using these global resources is the length of time required to negotiate access to the range by existing telecom operators and service providers. This may be less of an issue when global resources are used in the context of mobile services because of the way mobile resources are

provisioned using the GSMA's processes. Indeed, one of the benefits of using an ITU IMSI (901)[40] is that GSMA specifies the use of such codes -- for example, for aeronautical and maritime billing.

For service providers, the ability to have a single resource that they can use with enterprises globally is a unique selling point. It means that, with the appropriate management interface portal, the enterprise can manage the resource themselves. The alternative to a single code at one stage is to have multiple codes for each country in which the service provider operates. This is now being ameliorated by the emergence of extra-territorial use of numbers, which was not permitted a few years ago in Europe, but the changes being proposed in the EC's European Electronic Communications Code is starting to make that possible. As a result, the demand for global numbers for M2M/IoT may increase if the extra-territorial use of national numbers is not universally accepted.

For regulators such as ComReg, the benefit of a global number is to mitigate the demand for national resources. Also, there is the potential for avoiding the need to manage national resources that are used on an extra-territorial basis. However, the global code assignment rules are set by the ITU and only require a commitment to comply with the ITU's rules established for the global code. In allowing the use of such resources in a national context, regulators need to consider what General Authorisation conditions they need to establish to allow these resources to exist in a national context. For example, while the ITU may not require these numbers to be portable, it is possible – at a national level - to require service provider portability to be supported, and for the protection of consumer rights. It is also necessary that use of these global resources does not offer an advantage that does not exist with national numbers and that there is transparency for all players to avoid undermining competition.

Other than to note the existence of these global codes, and the on-going discussions around their use for M2M/IoT services that could change the demand for such international codes, they will only be considered further in terms of recommendations for amendments to the Numbering Conditions.

Stakeholder	Cost	Benefit

[40] The ITU IMSI is administered by the Director of the ITU Telecommunications Standards Bureau, with advice from the relevant technical group according to the criteria in Recommendation ITU-T E212

End User **IoT users**	• No Impact • Selection and implementation of technology to support M2M/IoT • Ensuring technology allows for Service Provider Switching • Deploying numbers in support of commercial operations	• No impact Capability of using a number range extra-territorially overseas
Network Operators/Service Provider	• Developing systems to accommodate potential new number lengths • Ensuring capability to provide Service Provider Switching • Demonstrating capability to manage numbering resources to meet possible assignment rules	• Potentially Specific Conditions of Use that support extra-territorial use
ComReg	• Ensuring use in a national context doesn't undermine competition	• Avoids use of national numbers and potential number exhaustion

Table 5 M2M Option 3 Use of a Global Number

4.5 Options for Over-the-Top (OTT) Services

Over-the-Top Services (OTT) are often considered interpersonal communication services offered to customers (both residential and business). However, the term OTT covers more than interpersonal communication services. BEREC, in its Report on OTT Services[41], recognises both the fact that OTT is not well defined, and consequently, it is used in association with an array of services, often leading to confusion. There have been efforts in recent years to provide a taxonomy of OTT services, such as the BEREC report on OTT services[42]. BEREC also notes that there is a lack of clarity in defining Electronic Communication Services. Recently, the issue of what is, and what is not, an OTT service has surfaced in ITU-T. Submissions made to technical groups in the ITU have re-enforced that confusion.

[41] See BEREC Report on OTT Services – (BoR (16) 35) January 2016

[42] Ibid.

OTT Services requiring mobile numbers/MNCs will be those that need to interconnect with the PSTN. Service Providers who are offering OTT services will need to comply with regulatory requirements and manage their assigned resources.

The confusion is that not all services that can be characterised as being OTT are in competition with electronic communications services. Therefore, not all OTT services require telephone numbers.

BEREC identifies the following three classes of OTT services:

- OTT-0 a replacement for electronic communication services (ECS),
- OTT-1 potentially competitor to an ECS, and
- OTT-2 other OTT services.

Category	Description	Numbering Requirements
OTT-0	Replacement to existing ECS	Fixed, Mobile and Global
OTT-1	Complimentary to existing ECS	Limited
OTT-2	Content activity	None

This report only considers the implications of OTT-0 and OTT-1 services. The introduction of these services and the potential that they have to provide customers with competitive interpersonal communication services will bring new service providers to the market. The services that will exist will vary greatly, as will the need, and demand, for telephone numbers. However, where services in the category of OTT-0 and OTT-1 make use of telephone numbers, they should do so in a manner which is familiar to customers to gain the greatest benefit from their deployment. Naturally, they must also comply with the Numbering Conditions. This is more likely to be relevant for those service providers of services that are OTT-0-like than those of OTT-1-like services.

For end users, the benefits of using existing mobile ranges include knowledge of the numbers, and the charges that are associated with using such numbers. The introduction of new numbering ranges has historically been recognised as a barrier to adoption by consumers.

For potential new service providers and network operators, the benefits of using current mobile ranges for OTT-1 services are:

1) that the existing number ranges are established; and,
2) that those ranges are predominantly used on mobile phones.

They are well understood by end users. In addition, they are established in the networks of other operators, and therefore interconnection should be easy. However, they may not offer price points that the OTT service providers desire.

In using existing mobile number ranges, ComReg benefits from a business-as-usual approach to the allocation of such resources.

This was similar to an approach undertaken in the UK, with respect to geographic numbers in areas of potential exhaustion. Ofcom initiated the discussion two years before introducing such charges to avoid conflict with other measures to make numbers available. This timetable saw a return of numbers that avoided the introduction of other measures, such as overlay numbering space in geographic areas, and facilitated better number management by the industry. ComReg should investigate a similar strategy.

The extent to which OTT services require numbers, either fixed or mobile, is difficult to quantify, and will occur only when the OTT service is a direct replacement for an existing service, namely OTT-0. For such services that substitute fixed or nomadic services then there are geographic and 076 ranges available. Where OTT-0 services require mobile numbers, then their allocation and use should be used in accordance with criteria set out in the Numbering Conditions of Use. OTT-1 services that are complimentary to current services and that are implemented as communication between two users of the same application do not have an evident need for numbers. There are some OTT-1 implementations that may start off as such, and then migrate to OTT-0 implementations. For example, an end-user initiating a call on Wi-Fi, and migrating to mobile telephony access, such as 4G, to maintain the call. If this were the case, then the operator initially providing the Wi-Fi access would need to act, as a minimum, as an MVNO to enable such a transition. In many cases, such a transition takes service on networks from an existing operator rather than on their own network – seamless continuance of a call is not possible. Where an OTT-1 service provider does not have

access to an OTT-O service provider's connectivity, the OTT-1 Service cannot be considered a mobile service. Connectivity between Wi-Fi networks does not support mobility.

Many cases of interpersonal communication are between two entities using the same OTT service -- so-called "on-net" calls. The connectivity strategy typically utilises numbers as names, relying on IP addresses as the underlying routeing mechanism, and therefore might well have no requirement for national telephone numbers. In many cases, the names that are used include alpha characters. Telephone numbers are often used for connecting the OTT service to traditional telephony services, so-called "off-net" calls. In some of these cases, the OTT services are re-using the numbers that are allocated to customers or end users. The use of telephone numbers in the "off-net" scenario can be either fixed or mobile.

The deployment of smartphones, and the access that such phones offer to customers of OTT services, requires consideration of the impact that this might have on the demand for mobile numbers. Consumers already use mobile numbers for other services, and as such, have a level of expectation based on knowledge derived from such use. Using these numbers in OTT settings needs to be consistent with consumer expectations of those numbers.

If the allocation of national telephone numbers is for services that are customer oriented then, for transparency and consistency, the same rules should apply (e.g. provision of access to emergency services be subject to number portability, etc.). In effect, the allocation of numbers to such services should be seen as business-as-usual. Consistent with this, only the impact on mobile numbers is considered further.

No matter what range is eventually used, network security needs to be addressed. The issue of network security is addressed BEREC's report (Enabling the Internet of Things (BoR (16) 39)) that obligations have been imposed on providers of publicly available networks and services. Noting that M2M/IoT and OTT fit the criteria of publicly available networks and services it follows that security should be the responsibility of service providers.

4.5.1 Option 1: Use of Current Number Ranges

The focus of the use of national telephone numbers is, in BEREC's[43] taxonomy, either a replacement for Electronic Communication Services (OTT-0) or as a competitor of such services (OTT-1). As a result, utilising numbers from a number range for similar services could be seen as business as usual for the stakeholders involved.

For consumers of such services, the benefit of using existing mobile numbers is that such numbers would be well understood. The rights of use that consumers have over existing numbers for ECS services could easily be applied to numbers allocated for OTT. These rights include number portability, provision of Calling Line Identification among others.

For operators and service providers, there is little cost required to introduce these numbers. For existing service providers, the process for building these numbers on the network is business-as-usual as similar numbers already exist. For new service providers, the costs of using existing numbers could include the cost of providing service and the cost of meeting the requirements of Conditions of Use, such as number portability. However, this is not specific to OTT service providers, but true of any new entrant to the market.

In utilising the existing mobile number ranges, providers of OTT-0 services would need to comply with the General Conditions of Use. Whether the Conditions of Use for MNOs or MVNOs is appropriate is dealt with elsewhere.

Stakeholder	Cost	Benefit
End User	• Potential new number if number range expanded to meet demand	• Use of existing to knowledge to communicate • No perceived barriers from the number to using the service
Service Provider/Operator	• Underutilisation of allocated numbers driving exhaustion • Better management of existing allocations	• Numbers are known within the industry • No additional regulatory requirements

[43] Report on OTT Services BEREC (BoR (16) 35 January 2016

		• Only requires amendments to commercial interconnection arrangements
ComReg	• Better Utilisation of current number resources • Avoid additional number utilisation and potential exhaust of national numbers	• Business as usual • Greater utilisation of current numbering resources

Table 6 OTT Option 1 Use of Current Number Ranges

4.5.2 Option 2: Use of a New Number Range

In assessing the use of a new national mobile range for OTT services, a key question is whether there is sufficient demand to warrant opening up a further range. While the extent to which demand for mobile numbers is great enough is addressed elsewhere[44], the focus here is on what benefit would accrue to stakeholders in having a new mobile range.

New number ranges always are treated cautiously by consumers because they are not familiar with their properties. While the number may, in this instance, appear similar to other mobile numbers in use, hesitation on the part of users, based on this uncertainty, could be a barrier to initial uptake, and hence, a barrier to competition. Part of this hesitation to use new numbers relates to the retail tariffs associated with the number.

For service providers who are assigned these new resources, the costs include:

- having to build them into the network and support systems,
- the additional cost of communicating the existence of the new codes,
- possibly seeking to have them opened up overseas, and,
- ensuring that their use nationally complies with the general Conditions of Use.

For new service providers, additional costs would accrue from establishing the necessary processes to conform to the current numbering Conditions of Use (e.g. number portability).

[44] See Annex C for detailed analysis of demand.

For ComReg, there is the requirement to ensure that any new range that is introduced has the appropriate rights and Conditions of Use relating to mobile telephone numbering ranges for similar services.

Stakeholder	Cost	Benefit
End User	• Barrier to using the number from lack of knowledge • Potential confusion with other current allocations for telephony	• No cost
Service Provider/Operator	• Building new range into network • Developing systems to accommodate new number ranges	• Numbers are available • Ability to deliver service and generate revenue
ComReg	• Identifying and making use of new number ranges • Overseas notification • Managing a number change	• Use existing conditions and rights of use • Numbers available to support competition and innovation

Table 7 OTT Option 2 Use of New Number Ranges

4.5.3 Option 3: Use of a Global Number

The criteria used by the ITU to assign these numbers includes the following requirements:

- the application does **not** duplicate a voice service; and
- the applicant manages the network end to end, either directly, by owning the network, or indirectly, by entering into a commercial relationship.

The types of OTT services that could seek to have global numbers allocated to them would be for voice-based communication services over Wi-Fi. The requirement for allocation of global resources is that in addition to not duplicating a voice service, the service provider controls (either directly or through commercial arrangement) the network. The potential to use Wi-Fi as an access mechanism is to use technology not under the control of the service provider and thus fail to meet the criteria for assignment. As a result, these numbers are not considered further as an option for OTT.

4.6 Additional Issues

4.6.1 International Mobile Subscriber Identifiers (E.212)

This report refers to the impact of the various numbering options on the two types of IMSIs: the national IMSI and the global IMSI. In both cases the structure is the same, specifically a three-digit country code, a two or three-digit Mobile Network Code, and 9 or 10-digit Subscriber element. The overall length of the IMSI is 15 digits. While the national MNC is assigned to and administered by a national regulator (in a manner similar to national telephone numbers), the ITU assigns and administers the global IMSI (i.e. Mobile Country Code 901).

In considering how IMSIs support M2M/IoT or OTT services, it is important to focus on the Mobile Network Code (MNC) of the national resource for the following reasons:

- The national MNC is administered by ComReg under the auspices of the Conditions of Use. This specifies the Rights of Use associated with MNCs, and focus on mobile terminals and mobile end users. With respect to M2M/IoT, an important question is whether the current Conditions of Use would allow allocation of an MNC in support of M2M/IoT services. If an MNC was allocated for this purpose, consideration would have to be given to the issue of whether there is sufficient capacity to support potential demand. It is not currently possible to share an MNC between operators. However, two options exist for the assignment of the Mobile Network Codes from the national range. First, an MNC can be directly assigned to an operator. Second, an operator can allow an MVNO to use part of the range (e.g. an MVNO, with whom a commercial arrangement exists). In the Numbering Conditions, the requirement to be classified as an MVNO means that they must have a commercial relationship with an Irish MNO. The variations in entities that have access to E.212 resources that exist in Europe reflects flexibility in an approach of who may be assigned numbers. The Netherlands is perhaps the most flexible in assigning E.212 resources to Mobile Virtual Network Enablers (MVNEs) and Mobile Virtual Network Aggregators (MVNAs). Services provided by MVNEs include SIM provisioning and configuration, customer billing, and customer relationship management. Mobile Virtual Network Aggregators (MVNAs) utilise services offered by MNOs, MVNOs and MVNEs but in a manner that allows the aggregator to brand the service as their own. The eligibility criteria for MVNEs and MVNAs to be able to

implement M2M/IoT or OTT-0 services is to have a commercial relationship with an existing MNO or MVNO.

- For those entities that would implement M2M services in a competitive and innovative environment, the requirement for the MVNO to have a commercial relationship with an Irish MNO appears restrictive in the face of allowing extra-territorial use of numbers to occur. The eligibility criteria for the assignment of MNC resources in support of M2M/IoT could be amended from the current approach to one where an M2M/IoT service provider is not required to have a relationship with an Irish MNO. It is possible to be more flexible when revising the Conditions of Use in terms of the rules governing the allocation and use of MNCs. However, an ongoing concern is the limited resources that are currently available behind Ireland's Mobile Country Code of 272. Ireland currently allocates, as does the rest of Europe, 2 digit MNCs. Therefore, the 100 MNCs are a limited resource. Should there be sufficient demand to exhaust this country code, rules exist in the ITU-T for allocating additional Mobile Country Codes to the Member States who have a demonstrable need.

  Entities requiring IMSIs to identify equipment will need to have a commercial relationship with an Irish MNO.

- The global IMSI is allocated by the ITU-T to service providers. A service provider must satisfy the criteria that exists in ITU-T Recommendation E.212 to receive an E.212 resource. At the same time, the service provider must also apply for an E.118 "Issuer Identifier Number".

An alternative to the allocation of National Mobile Network codes is an allocation of a global Mobile Network Code. Global MNCs are allocated by the ITU behind mobile country code 901. The criteria that must be satisfied in Recommendation ITU-T E.212[45] includes:

a) deployment in more than one country, and
b) that such deployment is in accordance with the rules of those countries.

[45]ITU T Recommendation E.212 Annex A

The focus of the Conditions of Use is on the national MNC resource, not the global resource. While global MNC resources may be considered as an alternative to national resources to reduce potential demand and exhaustion of national resources.

There is no reference in the Conditions of Use and application process in relation to the "Issuer Identifier Number", as specified in ITU-T Recommendation E.118 and used in relation to a SIM Card or as part of the Integrated Circuit Identifier on eSIMs.[46]

4.6.2 Numbering **Conditions**

The current Numbering Conditions focuses on national resources, and conforms to the requirements of European Union Directives. The EU has recently issued a draft European Electronic Communications Code that, if adopted, would require amendments to the Numbering Conditions.

One issue not addressed in the draft European Electronic Communications Code is bi-lateral agreement/notification for extra-territorial use. The issue of extra-territorial use is addressed in ITU-T Recommendation E.212 Annex E. This ITU annex cites the extra-territorial use of these resources as exceptional. However, the draft European Electronic Communications Code seeks to make this use business-as-usual. To assist in developing the M2M/IoT market, ComReg should consider notifying the ITU of the ability for specific resources to be used in this manner. This will not only allow national resources to be used in confidence, but also allow them to be used outside of the area covered by the draft European Electronic Communications Code. Further consideration of the detail of achieving this is outside the scope of this report, and is possibly an issue to be addressed by BEREC at a date in the future.

In the future, bilateral agreements for the use of national E.212 resources are a possible topic for revision to the Numbering Conditions. Any review of the conditions in support of the extra-territorial use of national numbers, in support of M2M/IoT, should seek to ensure that the use of numbers conforms to related national legislation, such as consumer protection.

[46] TS.25 Mobile Network Codes and Names Guidelines and Application Form GSM Association Version 1.0 20 September 2013.

The current Numbering Conditions does not take account of either the M2M/IoT requirements for new mobile national numbering resources, nor how such resources could be used to comply with the EU's draft European Electronic Communications Code (once approved). For example, the ability to use mobile numbering resources specifically for M2M/IoT used extra-territorially overseas would need to be specified, as would the conditions indicating who could be assigned national numbering resources be they telephone numbers, IMSI's or Issuer Identifier Numbers. This latter category is not currently included in the Numbering Conditions.

Issue Identifier Numbers (IIN) are used to identify entities who can issue SIM cards as well as eSIMs. These resources are used in conjunction with E.212 resources. Though the IIN resources are allocated by the ITU, they require National Regulator action as part of the assignment process of the IIN.

The conditions that would need to be addressed would include:

- the need of the service provider to support service provider switching,
- the extent to which access to emergency services, as part of the M2M/IoT service is required,
- the registration of information with the proposed BEREC service (should that be included in the final version of the European Electronic Communications Code), and
- conformance with national regulations.

For service providers to be allocated numbers from a potential new range for M2M/IoT services, they should have commercial arrangements that reflect implementation is for M2M/IoT services. This approach is in line with that taken for allocation of consumer mobile ranges. For OTT-0 services, they would have to comply with the requirements as stated in the Numbering Conditions.

A further point to consider for inclusion in any revised Numbering Conditions is the extent to which the providers that implement global numbers in Ireland, in support of M2M/IoT, would need to be authorised to ensure equivalence of competition. .

4.7 Conclusions and Recommendations

Recognising that M2M/IoT services are distinctly different from other mobile consumer services - including some OTT services - it is recommended that a new number range in the 08x ranges is introduced for M2M/IoT technologies. It is also recommended that numbers within this new number range be the maximum allowed 15 digits long (including country code). This will maximise the availability of numbers and futureproof the new number range.

The focus on utilising a currently unused 08x range will provide a distinct range that allows these technologies to be introduced, while exploiting its proximity to existing mobile numbering ranges. This will also avoid any direct, negative impact on current mobile numbering ranges. Noting that it is distinct from the current ranges, it is also essential that the rights of use for such new number ranges (for example, to include service provider switching) are included in a revised Conditions of Use.

The regulatory environment of a new mobile number range for M2M/IoT needs to be clearly defined. The need to allocate numbers to M2M/IoT services has emerged since the most recent publication of the current Numbering Conditions. In addition to the need to support competition (by widening the entities who could be recipients of numbering resources, and the need to support service provider switching), clarity is also required around the use of such numbers extra-territorially, the criteria for allocation, and the management of the resources. This should also be included in any revision to the Numbering Conditions.

The current mobile numbering ranges used by MNOs and MVNOs for mobile telephony services are heavily utilised. It is not considered a significant issue at this point in time as there appears to be sufficient capacity for the foreseeable future. In 2016, Analysys-Mason predicted an exhaust of consumer mobile ranges by 2023 should prevailing trends continue, but possibly moving forwards as early as 2019 should demand from usages such as M2M accelerate rapidly. If the previously identified conservation measures have had the desired impact and, depending on how rapidly M2M-driven demand for mobile numbers develops[47], then it is expected that the predicted deadline of

[47] Especially those intended for permanent extraterritorial deployment outside Ireland

2023 may recede further in time. However, at some point in the future, when faced with the exhaust of current numbering resources, conservation could be incentivised by consideration of charging for resources that are allocated. As cited above, this was undertaken by Ofcom in the face of exhaust in some geographic areas; it was a strategy that resulted in spare numbers being returned.

To support competition and innovation with respect to M2M/IoT and OTT, it is important that there are clearly specified responsibilities regarding the management of assigned number block resources. Those stakeholders that are assigned numbering block resources should have clearly defined obligations to manage such number blocks. These responsibilities include recycling of numbers in a timely fashion and achieving a level of utilisation before applying for new numbering resources.

In support of clearly specifying the responsibilities, operators and service providers should be required to report on utilisation and projected requirements for growth of services annually. Such reporting can assist in ensuring the continuing availability of numbering resources.

Though exhaustion of current mobile numbering resources is not deemed to be an immediate issue, ComReg should continue the use of conservation measures. This may include charging for numbers, as an approach to avoid the disruption of having to make more resources available.

If the demand for OTT numbering resources is significant, consideration could be given to expanding number lengths in the current mobile number ranges to increase the mobile numbering stock. The decision to undertake this action should occur when the numbers remaining in the current mobile numbering range hit a specific threshold. For example, the threshold could be two years prior to the expected exhaustion of numbers, at the current rate of demand. This is sufficient time to notify operators of the intention and to set a date for the additional number length to be brought into service.

The alternative to extending the number length is to bring a new number range into service (i.e. 082 for P2P communication services). As this is building upon existing number ranges, and can be viewed as business-as-usual, the time needed to bring in new numbering ranges be as little as 12 months.

5. Recommendations

5.1 Service Provider manage the numbers that are assigned (See Sections 4.3.1, 4.4.2, 4.5)

5.1.1 Recommendation

ComReg should continue to require Service Providers to efficiently manage their allocation of numbers to ensure they maximise utilisation.

5.1.2 Rationale

As identified in a previous study[48] there are opportunities for service providers to act to better utilise the resources that they have been allocated.

In 2016, ComReg agreed with industry a number of measures to ensure that service providers use mobile numbers more efficiently.[49] The agreed measures should ensure that the future requirement for existing mobile numbers, based on the current allocation trend, can be met from the current mobile numbering ranges beyond 2024.

Extending the lifetime for the use of current mobile number ranges will benefit all stakeholders. In turn, this will minimise the need for new number ranges for consumer mobile communications, number changes, and the costs that these would incur.

5.2 Needs-based allocation (See Sections 4.4.2)

5.2.1 Recommendation

Service Providers should ensure that, in requesting additional resources, their approach towards managing existing resources justifies the request.

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[48] Analysis Mason report for ComReg (ComReg 16/20a) – Conservation Measures to meet future demand for Mobile numbers

[49] ComReg Information Notice (ComReg 16/20) – Conserving Geographic and Mobile Numbers

5.2.2 Rationale

ICC notes that ComReg may consult further, as part of a public consultation to amend the Numbering Conditions, on the possible introduction of mandatory targets for number utilisation.[50] Mandatory targets would require Service Providers to justify additional requests for numbers based on the use they are making of their existing allocation. This will ensure maximum utilisation of national numbers.

In the long term this reporting will ensure that new number ranges, or number changes, only occur as a last resort. It will also help ensure that current ranges achieve maximum use and benefit all stakeholders.

The allocation of resources based on demonstrable needs will benefit all stakeholders by avoiding costs incurred when introducing new number ranges.

5.3 08xx anomaly (See Section 4.3.1)

5.3.1 Recommendation

ComReg should only turn to the 081 and 080 numbering ranges -- for possible future use as mobile ranges -- when there are no other 08x ranges available.

5.3.2 Rationale

The current assignments in 081 and the potential confusion with the UK's 0800 range have the potential to cause confusion for consumers, as outlined in Section 4.3.1. The existence of the legacy range – i.e. 0818 -- for universal access, is understood by consumers as national rate phone calls. Even taking into account the approach to the use of the 080 and 081 number ranges, sufficient numbering resources are available to meet the foreseeable demand for mobile numbers, as indicated in the rationale for Recommendation 5.1.

[50] ibid

080 should be avoided and should not be brought into service other than as a range of last resort for consumer mobile numbers. If it were, it would experience a potential clash with the UK's free phone numbers of 0800 and 0808, and cause potential confusion with Universal International Freephone numbers (00800).

5.4 Extra territorial Use of Numbers (See Sections 4.4.2, 4.4.3, 4.6.2)

5.4.1 Recommendation

ComReg should explicitly permit numbers and MNCs, assigned to undertakings for M2M/IoT services, to be used outside of its jurisdiction.

5.4.2 Rationale

Because of their nature M2M/IoT services can be provided across different territories from the provider's 'home country', therefore in order to facilitate M2M/IoT services ComReg should explicitly permit numbers and MNCs, assigned for M2M/IoT services, to be used outside of its jurisdiction.

In order to address competition issues in the M2M market the EC, in its draft European Electronic Communications Code, has proposed that national regulators allow the extraterritorial use of national numbers within the EU for M2M/IoT services. This would allow the extraterritorial use of certain numbering resources within the EU, subject to appropriate safeguards to protect end-users in all Member States where the numbers are used.

Where national numbers are used extra-territorially, the use should be in a manner that does not undermine the public policy concerns of the country in which they are being used (BEREC report: Enabling the Internet of Things (BoR (16) 39) February 2016).

Notification to the ITU of a specific range for M2M services that has been allocated from the Irish national numbering resources will facilitate the use of such numbering resources outside of Ireland. Setting aside the role of any notification E.164 number assignments to BEREC, undertaking activity to benefit the use of Irish numbering resources supports those service providers that choose such a

range for their service(s). The notification, which is voluntary, should be sent to the TSB of both the opening of the range and of the assignees of resources from that range to allow overseas operators to route and charge for use of those numbering resources overseas. The resources covered are both E.164 and E.212 resource

5.5 Use of Overseas numbers in Ireland (See Section 4.1.1)

5.5.1 Recommendation

Service Providers that use telephone numbering resources from overseas and International administrations to provide M2M/IoT services and OTT services in Ireland, should be required to conform to the conditions for the provision of Electronic Communications Networks and Services as set out in the General Authorisation regime in Ireland, as well as complying with consumer protection legislation.

5.5.2 Rationale

Providers offering electronic communication services in Ireland are required to be authorised and to comply with all applicable legislation and laws, regardless of the numbers they are using, and in ICC's view this should continue to be a requirement for providers of M2M/IoT and OTT services using numbering resources from overseas and International administrations.

The possible requirement to support extra-territorial use of numbers -- as stated in the draft European Electronic Communications Code -- does not deal in detail with the differing regulatory environments that exist. It is important that the use of numbers in overseas administrations comply with the rules in the environments in which they operate. This is true for numbers being used from abroad in Ireland. It should also be made explicit in the conditions that govern the use of Irish numbers when those numbers are used abroad.

ComReg should ensure the Conditions of Use that apply to Irish national numbers also apply to global or resources from other Countries deployed in Ireland. The draft European Electronic Communications Code has an important provision for this. It proposes that a request from an EU national regulatory authority – which demonstrates a breach of relevant consumer protection rules or number related national laws of the Member State in which the numbers are being used -- can

withdraw the right of extra-territorial use. Additionally, NRA's can seek to block access to numbers where fraud or misuse is occurring.

The application of this recommendation will ensure that there is a consistent approach to the use of resources that are deployed in the provision of M2M/IoT services and OTT services.

5.6 Use of Global Codes (See Section 4.4.3)

5.6.1 Recommendation

Use of global codes assigned by the ITU (Recommendations ITU T E.164.1 and E.212) to service providers, for the purposes of M2M/IoT, should be clearly stated in the Numbering Conditions.

5.6.2 Rationale

Permitting global codes assigned by the ITU is a useful mechanism to meet different requirements of stakeholders. For national regulatory authorities, it allows an alternative resource, other than national numbers, and therefore avoids a potential drain on national resources. For Service Providers, it permits a single resource to be deployed in support of a global product. It also minimises the overhead of managing multiple national numbering resources. However, it is important that, where such numbers are used, they conform to the regulations of the country in which they operate.

Use of (ITU administered) global resources that are directly allocated to Service Providers for deployment of M2M/IoT services has the potential, as noted elsewhere, to alleviate the demand for national resources. Furthermore, the use of these global codes allows for innovative commercial arrangements to be developed, and deployed, in the use of M2M/IoT services. These commercial arrangements may not be possible with national resources.

5.7 OTT Service Provider Eligibility for E.164 Mobile Numbers (See Section 4.5)

5.7.1 Recommendation

Providers should be eligible to apply for E.164 mobile numbers for services that qualify as an ECS and have a contract with an Irish MNO to access their network, provided they can justify the requirement.

5.7.2 Rationale

Providers that offer OTT services that qualify as an ECS and which have a contract with an MNO that allows their customers to roam on to the MNO's network should be eligible to apply for mobile numbers. As described in section 4.5, there are OTT service models which are similar to the MVNO service model and may require mobile numbers in certain cases.

Therefore, we recommend that ComReg should consider expanding the eligibility for mobile numbers to OTT providers that have a contract with an MNO that allows their customers to roam on to the MNO's network.

5.8 OTT Service Provider Eligibility for E.212 resources (See Section 4.6.1)

5.8.1 Recommendation

Providers should be eligible to apply for E.212 MNCs for OTT services that qualify as an ECS and have a contract with an Irish MNO to access their network, provided they can justify the requirement.

5.8.2 Rationale

As described in section 4.6.1 there may be cases where a provider of an OTT service requires an E.212 MNC to identify their subscribers if they roam on to an MNO's network. Therefore, we recommend that ComReg should expand the eligibility for E.212 MNCs to OTT providers that, for

example, have a contract with an MNO that allows their customers to roam on to the MNO's network.

5.9 Eligibility for E.164 and E.212 mobile resources (See Section 4.6.1)

5.9.1 Recommendation

Providers of M2M/IoT services should be eligible to apply for E.164 numbers designated for M2M/IoT services and E.212 resources provided they can both justify the requirement and can demonstrate that they can manage the resources.

5.9.2 Rationale

It is important that the allocation of national resources for the provision of M2M/IoT services include a degree of flexibility to support innovative services and future, emerging requirements. When considering eligibility criteria for E.164 designated for M2M/IoT services and E.212 resources, providers of M2M/IoT services in Ireland should be eligible to apply for these resources provided they can justify the requirement and demonstrate they can manage the resources.

5.10 New Number Range for M2M/IoT services (See Section 4.4.2)

5.10.1 Recommendation

That a new range be allocated from the 08x range of the Irish national numbering resource -- specifically 088 -- to service providers for the purpose of providing M2M/IoT services.

5.10.2 Rationale

Increasingly, M2M/IoT services are mobile-like, and are potentially being provided by using numbers on an extra-territorial basis.

In section 3 we forecast that between 21 million and 70 million Irish mobile numbers will be required for national and global M2M/IoT services by the end of 2022. Because numbers for M2M/IoT service

in Ireland are currently sourced from existing 08X ranges, there will be insufficient capacity to address the forecasted demand. Therefore we recommend that ComReg introduce a separate and distinct 08x range for M2M/IoT services to avoid any impact on the users of current 08x ranges.

Were the current 08x ranges to be used, and the potential demand for M2M/IoT numbers be realised, consumers would be faced with potential number changes earlier than currently anticipated.

The introduction of the 088 range exploits the mobile capabilities associated with the 08x range (See section 4.1.1.), and yet avoids the impact upon current ranges. Use of a separate and distinct range within the 08x range will also allow for flexibility by the stakeholders.

For ComReg, this will allow for the deployment of numbers in support of innovation, with separate specific Conditions of Use, while also providing for the ability to meet the needs of Service Provider requirements for M2M/IoT numbers.

For Operators, a separate and distinct 08x range will facilitate numbers of greater length. This will overcome constraints imposed by the current mobile number structure or those that are a result of having to use mixed number lengths (and rules) within the same block.

The proposal to utilise a new range within the current 08x range for M2M/IoT services allows exploitation of the mobile nature associated with the 08x range. It also remains distinct from voice based P2P services that also utilise numbers in the 08x range.

Whilst 082, 084 and 088 may be considered equally as potential number ranges for M2M, the preference for 088 is because it was used for a previous mobile offering (based on TACS) and this may make it easier for M2M/IoT providers to get their assigned numbers open on international networks because the 088 range may still be recognised by international service providers.

Previous proposals by ComReg for M2M numbering included reference to 077, however as M2M/IoT services are mobile-like 077 should be avoided due to its similarity with geographic numbers.

5.11 Number length (See Section 4.1.1, 4.4.2, 4.7)

5.11.1 Recommendation

It is recommended that the number length for a new number range for M2M/IoT services be 15 digits (including the '353' country code for Ireland).

5.11.2 Rationale

Some national regulators, who have already assigned dedicated telephone numbering resources for M2M/IoT, have allocated numbers that make full use of the maximum 15-digit telephone number length (including country code). The potential impact upon service providers of using longer national numbers is discussed in Section 4.4.2. That approach is also supported within the recommendations from ECC/CEPT that "the number length in the new number range……should be as long as possible" (ECC Recommendation (11/03) Numbering and Addressing for Machine to Machine (M2M) Communications).

ICC notes that the current maximum number length in Ireland is 13 digits for mobile mail boxes, e.g. +353 8X 5 123 4567.

Utilising the maximum number length possible ensures that any deployment is safe from future number changes. This still makes it possible to exploit the current knowledge associated with the mobility aspects of 08x.

The impact of deploying the maximum length of 15 digits for the national significant number (as defined in Recommendation ITU-T E.164) for M2M/IoT as opposed to 12 and 13 digit lengths used for consumer mobile services protects lengths used for consumer mobile services. Such an approach offers the greatest number of potential numbering resources available for M2M with the benefit of protecting consumer understanding of the number spaces by distinguishing the M2M number range from the P2P number ranges and avoiding the need for subsequent number changes to meet increased demand.

5.12 Timelines for new numbers (See Section 4.4.2)

5.12.1 Recommendation

That the proposed new number range 088 be implemented within 12 months.

5.12.2 Rationale

The timeline for the introduction of a new number range (as opposed to numbering resources from an existing range) is based on best practice of introducing numbering ranges garnered from informal discussions with regulators who have knowledge and experience of this situation.

5.13 Fees for Numbers (See Section 4.5, 4.7)

5.13.1 Recommendation

Charging for numbers should only be introduced in order to extend the availability of the current P2P mobile and any future M2M number ranges.

5.13.2 Rationale

Charging for numbers is generally used to either cover the NRA's cost for administrating the National Numbering Scheme, or to ensure the efficient use of numbers.

EU NRAs may only apply two types of charging for numbers:

1) administrative charges in order to finance the activities of the NRA for the granting of rights of use. However, such charges should be limited to cover the actual administrative costs for those activities; and

2) usage fees may be levied as an instrument to ensure the optimal use of numbers

Charging as a method for ensuring the efficient use of numbers should be viewed as a preferred alternative to introducing a new 08x consumer mobile range, which avoids the impact of a new number range upon consumers and service providers.

ICC notes that ComReg has previously stated that it may consider introducing charges for numbers as a means of conserving numbers, if the other conservation measures should prove ineffective for

existing consumer mobile ranges.[51] ICC recommends that a similar approach on charging should also be taken for any future number range designated for M2M/IoT services.

5.14 Calling line Identity (See Section 4.4.2, 4.5.1)

5.14.1 Recommendation

The provision of calling line identification for M2M/IoT services should be determined by the nature of the service that is being implemented. For OTT services, it should remain a requirement.

5.14.2 Rationale

The provision of CLI for certain M2M/IoT services, such as safety applications, would be required to ensure that interrupted communications could be restored. CLI with respect to M2M/IoT cannot be universal, as the nature of the services provided will vary. However, for some services, such as safety (e.g. eCall, or lift safety), CLI is clearly required. This requirement is because the service requires limited voice communication for a period of time and requires the ability to restore interrupted communication. Setting the requirement for CLI across the wide variety of M2M/IoT services would have to be done on a case by case basis.

The required provision of CLI should be maintained for OTT services using mobile numbers. Providers of services that are authorised in Ireland are subject to the General Authorisation conditions, including conditions that apply in respect of Calling Line Identification. Having reviewed these CLI conditions, ICC considers that they also seem reasonable for OTT services that use numbers.

5.15 Conditions of Use for new M2M/IoT Range (See Section 4.4.2)

5.15.1 Recommendation

It is recommended that, in support of a new number range for M2M/IoT, numbers;

- ***Are brought into service in Ireland within 6 months of being allocated,***

[51] ibid

- ***have limited voice capabilities for access to emergency services for services such as eCall,***
- ***15 digits in length (incl. Country Code and Network access code), and***
- ***Are available to be used on an extraterritorial basis overseas (complying with the national regulations in the country in which they operate)***

Additionally, undertakings that are deploying numbers for M2M/IoT need to maintain the support for competition by ensuring that they can implement Service Provider Switching.

It is further recommended that allocations from current P2P ranges for M2M/IoT services are grandfathered (this would mean that while no further consumer mobile numbers would be assigned to M2M/IoT services, those that are currently assigned would not be forced to move).

5.15.2 Rationale

The use that is made of telephone numbers for M2M/IoT is different from the use of such resources for P2P communication. The two environments have completely different stakeholders. This needs to be specifically reflected in the designation and Conditions of Use that attach to such numbers.

M2M/IoT services also have a different architecture from P2P services. M2M/IoT services are often, in comparison to P2P services and applications, low in traffic, bursty and predominantly data. It is important that stakeholders understand that there are different, and distinct, conditions for number resources deployed for M2M/IoT compared to more traditional P2P services.

5.16 Service Provider Switching (See Sections 4.4.1, 4.4.2, 4.6.2, 4.7)

5.16.1 Recommendation

It is recommended that M2M/IoT Service Providers utilising national numbers for M2M/IoT resources should be required to allow their subscribers to switch suppliers (Service Provider portability) and that, as far as possible and where appropriate, such provision should use existing number portability processes.

5.16.2 Rationale

The ability to switch Service Providers underpins the concept of competition and of consumer choice and applies equally to the M2M/IoT context as it does to traditional telecommunications. The current Number Portability processes are focussed on end users initiating the process.

The ability for a M2M/IoT subscriber (i.e. large enterprises supplying M2M/IoT services) to switch between Service Providers must be independent of the technology that supports the service. In many cases, as M2M/IoT services support mobility, there exists a requirement for a SIM card, either physical or embedded. It is the numbers associated with the SIM that must change to support service provider switching.

Where appropriate, Re-use of existing MNP processes for national numbering resources should be considered to ensure the benefits that accrue from allowing subscribers the ability to choose their M2M/IoT service provider. The impact of such a choice will be different for M2M/IoT services compared to traditional telecommunications because of the different value chain that exists in M2M/IoT. However, the competition and economic benefits are perceived to be the same.

It is noted that there are two, main, methods to support the implementation of M2M/IoT, namely physical SIM cards or embedded SIM Cards. Each has advantages and disadvantages. Service provider switching is a requirement of either and is independent of such technology. The mechanism to support service provider switching is a matter of choice for the service provider to meet their commercial requirements. Over the Air (OTA) mechanism is cited in the draft European Electronic Communications Code, and therefore might be seen as the preferred option for this function, as opposed to physical change of equipment to support change of provider.

This recommendation takes a technology neutral approach to supporting the ability of M2M/IoT users to leverage competition and the focus is on the capability of a subscriber to be able to switch between M2M/IoT Service Providers regardless of the technology that they are using. This is so that M2M/IoT subscribers have the service and/or connectivity of their choice, and so, avoid service provider lock in.

5.17 eCall (See Section 4.4.2)

5.17.1 Recommendation

ComReg should designate a specific part of the new 088 range for eCall. In addition to making national numbers available for eCall as part of the range designated for M2M/IoT, other numbers should be allowed -- including numbers from overseas administrations and, where appropriate, ITU Global E.164 numbers.

Numbers that are allocated for eCall should be explicitly designated as such, to permit access to the PSAP in conformance with existing standards. Conditions of Use need to specify that only limited voice communication is supported. Calls to and from the PSTN should not be supported. To facilitate the PSAP being able to initiate a call, there will be a need for the number associated with the vehicle to be included as a calling line identifier in the original call. This should also be reflected in the Numbering Conditions.

5.17.2 Rationale

To ensure the cost-effective deployment of the eCall service, there is a need for flexibility in the use of numbers that can be used for eCall. This requirement gives Service Providers access to the widest possible source of numbers. Service Providers can utilise the appropriate numbers (i.e. country of origin or country of use), that most suits their commercial needs while meeting the need of the service. Such flexibility will also assist in the possible use of numbers outside of Europe in support of similar services.

The requirement to implement eCall from April 2018 (Regulation (EU) 2015/78 of the European Parliament) will place a demand upon national numbering resources. eCall occurs in the event of an accident between a car and Public Safety Access Point and supports a limited voice capability. Whilst the initial call is originated using an emergency number, the requirement for an E.164 number is to permit the PSAP to initiate a call to vehicle.

ICC's predictions of sales in Ireland of new vehicles equipped with eCall (private car, LCV and HGV) amount to 149,000 in 2018, 206,000 in 2019 and 214,000 in 2020. On this basis, a total of some

569,000 additional numbers would be needed to satisfy the demand for eCall-equipped vehicles in Ireland between 2018 and 2020. As already noted, however, extraterritorial use of numbers makes it by no means a certainty that all eCall-equipped vehicles sold in Ireland will be serviced by Irish national number resources whilst, conversely, there may be significant demand for Irish numbers to service eCall-equipped vehicles sold overseas.

Reference to Interim procedures for eCall to identify and allocate national mobile numbers will require further thought based on the above.

Allocating numbers from one of three potential sources will ameliorate the focus of the demand being upon the country of origin of the vehicle.

6. Annex A: Methodology of Country Selection and Benchmarking

6.1 Description of methodology: Country selection and benchmarking

The overall objective of Task 1 was to identify six international jurisdictions comparable with Ireland and for these to identify and compare relevant regulatory measures applied to the availability and management of mobile numbering resources for M2M, OTT and IoT services. From an early stage, it was agreed that five of these comparators should be drawn from Member States of the European Union, with one other international comparator from outside the EU.

Initial selection criteria included:

- the existence of specific and identifiable regulatory provisions for the allocation and management of numbering resources for M2M, OTT and IoT services;
- the availability of publicly-accessible information on any such provisions. In the interests of accuracy and verifiability of data, original-source English-language resources were preferred, though other examples were considered subject to ability to translate native-language documentation;
- socio-economic similarities between the comparator countries and Ireland (e.g. GDP per capita PPP, number of mobile subscribers, mobile teledensity, mobile coverage as a percentage of the population, M2M/embedded mobile subscriptions);
- any similarities in the regulatory systems and use of mobile numbering resources between the comparator countries and Ireland.

An initial selection was composed of the EU28 countries outside Ireland. On an international basis, Argentina, Australia, Brazil, India, Malaysia, Mexico, New Zealand, Hong Kong, Norway, Singapore, South Africa, Switzerland and the United States were also considered.

Preliminary examination of reputable public-domain sources such as the websites of the various national regulators and numbering authorities, along with the summaries of various National Numbering Plans published by the ITU, allowed the initial selection of 41 prospects to be reduced to 17. In the vast majority of cases, prospective comparators were eliminated due to there being no

indication of mobile numbering resource provisions for M2M, OTT and IoT services, or positive indications that specific provisions in these areas have not yet been deemed necessary by the competent authorities. In several cases, the limited or non-availability of English-language documentation and corresponding likely difficulties in accurately translating native-language materials were identified, thus reducing the viability of the subject as a research proposition. The 17 likely comparators and their observed characteristics relating to socio-economic, ICT development and overall regulatory aspects are summarised in Table 8 below.

6.2 Spreadsheet of Research

Country	GDPpc PPP, $, 2015	Population, 2015	Mobile Subscribers, 2015	Mobile Teledensity (%), 2015	% Population with Mobile Coverage, 2015	% Population with at least 3G Mobile Coverage, 2015	% Population with at least LTE/WiMax Mobile Coverage, 2015	M2M /embedded mobile subscriptions, 2015	M2M /embedded mobile subscriptions per 100 pop, 2015	VoIP subscriptions per 100 pop, 2014	IPTV subscriptions per 100 pop, 2014	Autonomous Regulator?	Regulator in charge of numbering?	Percentage of Regulator's revenues derived from numbering fees (if known)	Full competition in mobile sector?	Full competition in Internet services sector?
Ireland	54,654.40	4,726,856	4,902,009	105.07	99.00	95.00	90.00	554,070	11.94	7.95	0.40	✓	✓	N/A	✓	✓
Belgium	43,991.62	11,183,411	12,938,176	114.27	100.00	99.99	99.89	1,466,649	13.08	1.67	11.88	✓	✓	4.30	✓	✓
Croatia	21,880.48	4,255,374	4,415,660	104.43	100.00	99.06	93.08	..	..	21.01	9.25	✓	✓	9.00	✓	✓
Denmark	46,635.24	5,661,723	7,266,365	125.89	99.99	99.99	99.99	895,921	15.77	16.32	7.17	✓	P	< 1.00	P	✓
Estonia	28,094.80	1,280,227	1,903,545	160.69	100.00	100.00	100.00	180,887	13.77	20.38	13.00	✓	P	N/A	✓	✓
France	39,677.99	64,982,894	66,681,000	101.21	99.00	99.00	80.00	10,538,000	15.85	38.15	22.42	✓	✓	N/A	✓	✓
Germany	47,268.43	82,562,004	96,360,000	120.42	99.00	95.70	95.70	6,700,000	8.21	20.82	2.91	✓	P	0.10	✓	✓
Hungary	25,581.50	9,911,396	11,785,806	118.05	..	..	97.30	..	..	16.76	5.05	✓	✓	7.60	P	✓
Luxembourg	101,926.42	543,261	806,800	149.49	99.00	99.00	96.00	59,000	10.37	12.52	7.47	✓	✓	N/A	✓	✓
Netherlands	48,458.94	16,844,195	20,809,054	116.42	100.00	99.00	99.00	2,781,000	16.42	31.17	..	✓	P	9.00	✓	✓
Norway	61,471.57	5,142,842	5,841,088	116.13	100.00	99.00	95.00	1,221,650	23.54	8.01	8.60	✓	✓	N/A	✓	✓
Spain	34,526.50	47,199,069	50,925,523	107.85	99.80	98.90	75.00	3,626,482	7.81	8.54	4.22	✓	P	N/A	✓	✓
Sweden	46,420.42	9,693,883	12,638,827	127.84	99.99	99.99	99.99	6,741,000	68.79	17.97	8.62	✓	✓	5.90	✓	✓
Hong Kong	56,719.50	7,313,557	16,735,727	233.62	100.00	99.00	99.00	..	..	14.64	17.57	✓	✓	N/A	✓	✓
Mexico	17,276.64	125,235,587	106,831,487	82.22	..	89.00	58.00	1,110,000	0.91	..	..	✓	✓	N/A	✓	✓
Singapore	85,208.81	5,618,866	8,211,400	146.89	100.00	100.00	100.00	..	..	12.61	..	✓	✓	2.00	✓	✓
South Africa	13,083.22	53,491,333	85,197,164	149.19	99.00	98.00	54.00	..	..	..	9.35	✓	✓	N/A	✓	✓
United States	55,836.80	325,127,634	382,307,000	110.2	99.90	99.90	99.60	49,271,000	15.32	16.70	4.00	✓	✓	N/A	✓	✓

Notes

The entry ' .. ' in any of the statistical data columns indicates that pertinent data is not available for that particular candidate.

Notation P denotes 'Partial' and signifies as follows:

- '*Regulator in charge of numbering?*' column – Regulator has only partial responsibility for numbering issues, e.g. shared with other body or perhaps responsible for implementation only with policy issues being decided by government
- '*Full competition*' columns – only partial competition has been implemented in the sector in question

'N/A' entry in '*Percentage of Regulator's revenues derived from numbering fees*' column denotes that either the regulator does not directly benefit from numbering charges (e.g. because such charges are not levied, or because regulatory budgets are met from direct government grant) or that the extent of such fees collected is not known

Data sources:

- GDPpc PPP – World Bank
- M2M/embedded mobile subscriptions – OECD *Broadband Portal*
- Regulatory characteristics – ITU *ICTeye*
- All other data – ITU *World Telecommunication/ICT Indicators Database* 2016 (VoIP and IPTV subscriptions per 100 pop InterConnect calculations based on ITU data from same source)

Table 8 Overall Comparison of Socio-Economic and Regulatory Factors Across Prospective Comparator Countries

In addition, a series of targeted questionnaires addressing specific aspects of numbering provision for M2M/IoT and OTT services was circulated by ComReg to contacts within various regulatory authorities via the CEPT ECC's Working Group on Numbering and Networks (WG NaN). For other countries identified by InterConnect as possible comparators, similar data was sought through reference to known public-domain resources.

From the foregoing, a final selection of six countries was discussed and agreed between InterConnect and ComReg. Parameters governing choice included:

- National characteristics; both socio-economic and regulatory:
    - Similarity in GDP per capita (governing likely affordability of advanced services) and population size (potentially determining upper levels of demand);
    - Similarity in mobile teledensity and uptake of M2M and OTT (VoIP and IPTV) services to date;
- Observed regulatory approach and presence of existing regulatory provisions to make numbering resources available for M2M/IoT and OTT service usage;
- Likely availability/ease of obtaining additional information to facilitate analysis.

7. Annex B: Detailed Analysis of Comparable Jurisdictions

7.1 Belgium

7.1.1 Regulatory Background

Numbering matters in Belgium are administered under the aegis of the national communications regulator, the Belgian Institute for Postal services and Telecommunications (BIPT). The underpinning legislative instrument governing numbering activities and the use of associated resources is the April 2007 Numbering Decree[52], supplemented and amended by various regulatory Decisions.

In September 2010, BIPT published a consultation paper on the determination of policy for M2M numbering. This referenced a CEPT WG NaN draft report on the likely need for numbers for M2M communication in Belgium, and requested input on a series of questions including estimates of required numbering capacity for M2M activities, preferred numbering approaches and associated regulatory conditions. A draft Decision was published and made available for public consultation on 14 April 2011, with measures being finalised in BIPT's Decision of 6th September 2011 concerning the determination of the numbering plan on the question of M2M communication[53]. This provided a formal definition of M2M services and designated a dedicated non-geographic number range for M2M activities, to be used exclusively for M2M activities and made available from 1st October 2011. From 1st October 2012, all new requests for numbers supporting M2M activities were to be met from the new range, with existing number allocations used for M2M purposes being subject to a 10-year transitional period, movement to the new range to occur not later than October 2021. After representations from various concerned parties, BIPT's Decision of 4th September 2012 modified that of 6th September 2011[54], extending the initial deadline for implementation to 1st September 2013 and that for final phasing-out of M2M usage of numbers in existing ranges to 1st September 2023.

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[52] On-line transcript at http://www.ejustice.just.fgov.be/cgi_loi/change_lg.pl?language=fr&la=F&cn=2007042729&table_name=loi

[53] http://www.bipt.be/public/files/fr/1857/3595_fr_besluit_m2m_nummerplan_fr_adopted_.pdf

[54] http://www.bipt.be/public/files/fr/20404/decision_4_septembre_2012_modification_decision_M2M_6_septembre_2011.pdf

A further consultation, in November 2014[55], addressed a variety of numbering-related issues, including a proposal to permit the extraterritorial use of national numbering resources (E164 and E212 MCC & MNC). A summary of conclusions to the consultation published by BIPT in August 2015[56] proposed the amendment of the Numbering Decree to facilitate the permanent use of Belgian numbers abroad and of foreign numbering capacity in Belgium in connection with M2M activities.

In January 2017, BIPT published a consultation regarding the numbering aspects of eCall services[57], the provision of which on new road vehicles will be mandatory across all EU Member States from the end of March 2018. Aspects of the consultation included:

- Whether eCall should be treated as an M2M service or some other special service;
- The likely extent of demand for eCall-related numbers;
- Likely options for E.164 numbers (an existing mobile service, a new M2M service category with a dedicated numbering range, use of ITU supranational E.164 numbers, extra-territorial use of national E.164 numbers);
- Options for E.212 MNCs, including the possibility of legislative provisions to regulate the extraterritorial use of E.212 identifiers;
- Whether the regulatory framework for portability of E.164 numbers should be adapted to eCall and other M2M applications;
- Whether a regulatory framework should be created for 'over the air' (OTA) provisioning of IMSIs in general and for eCall in particular.

OTT services are not recognised as a specific category in Belgian legislation, and providers of such services are subject to the same rights (including access to numbering resources) and obligations as any other provider of electronic communications services.

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55 http://www.bipt.be/public/files/fr/21394/Consult_review_KB_Nummering_FR.pdf

56 http://www.bipt.be/public/files/fr/21535/Public%20synth%20analy%20consult%20review%20KB%20N%20FR.pdf

57 Consultation à la Demande du Conseil de l'IBPT du 31 Janvier 2017 Concernant les Aspects de Numérotation des Services Ecall - http://www.bipt.be/public/files/fr/22101/Consultation_eCall.pdf

7.1.2 Detailed Provisions – Numbering for M2M

Formal Definition of M2M

Section 3.1 of BIPT's Decision of 6th September 2011 provides the following formal definition of M2M services:

> *Communication services where the data is automatically transferred between devices and applications, with little or no human interaction. When used in combination with other applications (e.g. voice) use the same number, it is not mandatory to use a M2M number, a geographic number (fixed line) or a mobile number can be used. However, the other applications must meet certain criteria and cannot simply be added in order to avoid the use of M2M numbers.*

Permitted Use of Numbering Resources for M2M

The use of both E.164 mobile numbers and E.212 Mobile Network Codes (MNCs) is permitted for M2M applications.

Since 1st September 2013, new requests for E.164 mobile numbers to support exclusively M2M activities must be satisfied from the dedicated 077 M2M range (q.v.). In the case of combined usage, however, e.g. where voice or other applications use the same number as an M2M application, a number from the appropriate fixed-line geographic or mobile range may be used instead. S3.1.3 of the Decision of 6th September specifically warns that such combined applications must be legitimate[58] and not simply represent an addition of a notional non-M2M application as a means of avoiding the use of the dedicated 077 numbering range for what is effectively nothing more than an M2M service.

'Legacy' numbers from fixed-line geographic or mobile ranges allocated for the exclusive use of M2M applications prior to 2011 may remain in continued usage, but must be transitioned to the new dedicated M2M range by 1st September 2023. BIPT considered that the 10-year transitional period was long enough to allow progressive and inexpensive removal of existing M2M applications using traditional fixed or mobile numbers.

[58] The example offered by BIPT was where an existing mobile voice customer wished to add a mobile broadband capability on the same number

There are no M2M-specific requirements relating to the allocation and use of MNCs.

Assignment of E164 mobile numbers and/or E.212 MNCs to undertakings other than MNOs or MVNOs

Article 4 of the Numbering Decree provides that E.164 mobile numbers may be assigned to providers of electronic communications networks or services providing mobile communications services. E.212 MNCs are assigned to electronic communication providers who have their own network elements.

The question of direct awards of M2M-related numbering resources to undertakings other than MNOs or MVNOs was highlighted in the 2010 Consultation and subsequent Decision of 6th September 2011, but was not proceeded with by BIPT at that time. The November 2014 Consultation on numbering issues questioned whether steps should be taken to introducing more flexibility in the allocation of E.212 MNCs, and S8 of BIPT's subsequent summary of conclusions [59] proposed alterations to the Numbering Decree to facilitate the direct allocation of MNCs to companies that were not MNOs but which were able to prove that they had engaged in commercial negotiations with an MNO and had a realistic intention to operate a service capable of using any requested numbering capability in a useful way. An amendment to this effect was expected to be put in place before the end of 2016, but consensus on this issue failed to be reached, and a wider review process on the Numbering Decree has now been suspended until the European Electronic Communications Code is adopted to minimise the risk of two successive revisions to the Decree being required within a short timeframe.

Availability of dedicated E.164 mobile number range for M2M services

The BIPT Decision of 6th September 2011 created a dedicated non-geographic range for numbering M2M services, composed of prefix of 077 (+32 77 for international calls) followed by 11 digits, i.e. to the basic format 077 ABCDE FGHIJK[60]. This was claimed to provide a total additional resource of some 100 billion numbers. M2M numbering resources would be allocated in blocks of one million numbers.

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[59] See http://www.bipt.be/public/files/fr/21535/Public%20synth%20analy%20consult%20review%20KB%20N%20FR.pdf

[60] S3.4 of the 2011 Decision indicates that, while at least one respondent to the 2010 Consultation suggested the adoption of a substructure allowing different sizes of numbering blocks and possible differentiation by M2M application, BIPT considered this step to be an unnecessary complication.

Permitted use of national E.164 mobile numbers and/or E.212 MNCs to be used on a permanent extra-territorial basis for M2M services

S10 of BIPT's 'Summary and further analysis answers of 28 July 2015 to the consultation on reviewing the policy regarding numbering plan management'[61] called for Article 8 of the 2007 Numbering Decree to be amended to permit the use on a permanent basis of Belgian numbers abroad for M2M applications. As with other numbering issues, this is now awaiting a wider revision of the Numbering Decree pursuant to adoption of the European Electronic Communications Code.

Permitted sharing by M2M service providers of E.212 MNCs

In their response to the November 2016 WG NaN questionnaire, BIPT stated that the concept of sharing was not addressed in Belgium's numbering regulation. It must, therefore, be assumed that sharing of E.212 MNCs is not explicitly permitted.

Fees for the assignment and/or use of E.164 mobile numbers

BIPT has published a scale of fees relating to the allocation and use of numbering resources in 2017[62]. According to this, a block of one million numbers on the 077 M2M range would attract a one-off application fee of €1,206 and an annual usage fee of €603[63]. Mobile numbers from the 'ordinary' 04 range (i.e. those used for voice services, or a combination of voice and M2M services) would command an application fee of €1,206 and an annual usage fee of €1,808 for a smaller (100,000-number) block size.

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[61] See http://www.bipt.be/public/files/fr/21535/Public%20synth%20analy%20consult%20review%20KB%20N%20FR.pdf

[62] Copy of document supplied by ComReg, 15th February 2017

[63] Annual fees for the use of M2M numbers were introduced by the publication of the Royal Decree of 4th April 2014

Differential treatment of applicable fees if mobile numbers are used for M2M services

There is no differentiation in fee scales for the 'ordinary' 04 mobile range based on whether the resource is used for M2M services. The dedicated 077 range may only be used for M2M applications, making the question redundant in this instance.

Fees for the assignment and/or use of E212 MNCs

The 2017 BIPT fee scale indicates a one-off application fee of €1,206 and an annual usage fee of €15,067.

Differential treatment of applicable fees if MNCs are used for M2M services

There is no differentiation in fee scales based on use of resource for M2M services.

Permitted use of overseas E.164 mobile numbers and/or E.212 MNCs on a permanent extra-territorial basis for M2M services

S10 of BIPT's 'Summary and further analysis answers of 28 July 2015 to the consultation on reviewing the policy regarding numbering plan management'[64] appears to call for Article 8 of the 2007 Numbering Decree to be amended to permit the use on a permanent basis of foreign numbering capacity in Belgium for M2M applications. As with other numbering issues, this is now awaiting a wider revision of the Numbering Decree pursuant to adoption of the European Electronic Communications Code.

Do Number Portability requirements apply to resources used for M2M services?

Standard requirements for number portability apply.

[64] See http://www.bipt.be/public/files/fr/21535/Public%20synth%20analy%20consult%20review%20KB%20N%20FR.pdf

7.1.3 Detailed Provisions – Numbering for OTT

Formal Definition of OTT

There presently exists no legislative or regulatory definition of OTT in Belgium. Providers of such services are subject to the same rights and obligations as any other provider of electronic communications services.

Permitted Use of Numbering Resources for OTT

The use of both E164 mobile numbers and E212 Mobile Network Codes (MNCs) is permitted for OTT applications.

Types of E.164 numbers permitted for use OTT services

The use of geographical and mobile ranges is permitted for OTT services. The Numbering Decree and Numbering Plan do not appear to provide for defined numbering ranges specifically for use with OTT services.

Assignment of E.212 MNCs for OTT services to undertakings other than MNOs or MVNOs

Only notified operators which own network infrastructure can apply for an E.212 MNC; they must fulfil the E.212 recommendation and demonstrate the need for a MNC.

Fees for the assignment and/or use of E.164 mobile numbers

For mobile numbers from the 'ordinary' 04 range (i.e. those used for voice services), the 2017 BIPT fee scale indicates a one-off application fee of €1,206 and an annual usage fee of €1,808 for a block of 100,000 numbers.

Differential treatment of applicable fees if mobile numbers are used for OTT services

There is no apparent differentiation in fee scales based on the use of resource for OTT services.

Fees for the assignment and/or use of E212 MNCs

The 2017 BIPT fee scale indicates a one-off application fee of €1,206 and an annual usage fee of €15,087.

Differential treatment of applicable fees if MNCs are used for OTT services

There is no differentiation in fee scales based on use of resource for OTT services.

Do Number Portability requirements apply to resources used for OTT services?

Standard requirements for number portability apply. There is no differential treatment of OTT services.

7.2 Denmark

7.2.1 Regulatory Background

Numbering resources in Denmark are administered by the Danish Energy Agency (Energistyrelsen - ENS), a multi-sectoral regulatory agency governing telecommunications as well as energy and water utilities. The underpinning legislative provision is the 2011 Act on Electronic Communications Networks and Services[65], of which Chapter III deals with numbering issues.

In 2011, the then-regulator published a recommendation about numbering resources for M2M communications[66], deriving from discussions held within a working group created by the regulator and various industry participants. Citing rapidly growing interest in M2M communication and resulting increased pressure on numbering resources, the regulator recommended that a specific number range be allocated for M2M applications, namely 12-digit numbers in the 37 numbering range (37cdefghijkl). These numbers would be non-geographic and so available for either fixed-line or mobile usage, provided that the service provided was an M2M service as defined by the regulator. In the first

[65] Unofficial English-language translation at https://ens.dk/sites/ens.dk/files/Tele/act_on_electronic_communications_networks_and_services.pdf A Danish-language summary of the associated National Numbering Plan may be found at https://ens.dk/sites/ens.dk/files/Tele/nummerplanen_2016_november.pdf

[66] Danish-language transcript at https://ens.dk/ansvarsomraader/telefoni/numre/numre-i-37-serien-til-m2m-tjenester

instance, however, only part of the series would be assigned, with the remaining numbers held in reserve and allocated as and when deemed necessary. The recommendation was ratified by the April 2011 Order on the Danish Numbering Plan[67], with the new dedicated range coming into use effective as of 25th May 2011.

InterConnect has not been able to identify any specific regulatory provisions relating to the provision of numbering resources in Denmark for OTT applications.

7.2.2 Detailed Provisions – Numbering for M2M

Formal Definition of M2M

S3 of the April 2011 Order on the Danish Numbering Plan defines M2M communication as a fully or largely automatically initiated communication over an electronic communications link between two or more predetermined devices, including via a mobile broadband network. While voice telephony services are not normally regarded as M2M communications, M2M communications may include voice telephony elements provided that they constitute an integral part of a largely automatic initiated communication service.

Permitted Use of Numbering Resources for M2M

The use of both E.164 mobile numbers and E.212 Mobile Network Codes (MNCs) is permitted for M2M applications.

Assignment of E.164 mobile numbers and/or E.212 MNCs to undertakings other than MNOs or MVNOs

Numbering resources may be assigned to any party deemed by the regulator to be a legitimate provider of telecommunications networks or services. There is no specific differentiation in terms of eligibility between MNOs, MVNOs, resellers, etc. Numbers within the dedicated M2M range, however, are available only to entities offering M2M services.

[67] Danish-language version at https://www.retsinformation.dk/forms/R0710.aspx?id=136741 Subsequent amendments published in August 2012 and November 2016 have not impacted the provision of M2M numbers.

Availability of dedicated E.164 mobile number range for M2M services

Pursuant to the 2011 M2M Recommendation and subsequent Order on the Danish Numbering Plan, 12-digit non-geographic numbers in the 3710 numbering series are reserved for M2M use, providing a dedicated resource of some 100 million numbers. These may be used for either fixed-line or mobile applications, providing that the essential characteristics of an M2M service are respected.

Originally, numbers were offered in initial blocks of 10,000, with the possibility of repeat orders of 1,000 for operators having minimal requirements. Since 3 November 2016[68], numbers have been available for allocation in blocks of 1,000 or 10,000.

The remaining 37-series numbers (number series 3711 - 3719 and 372-379) are presently held in reserve to be allocated as and when deemed necessary.

Permitted use of national E.164 mobile numbers and/or E.212 MNCs to be used on a permanent extra-territorial basis for M2M services

In its response to the November 2016 CEPT WG NaN questionnaire, ENS notes that this issue is not regulated in the Danish Electronic Communications Networks and Services Act. Accordingly, Danish legislation does not prohibit extra-territorial use of national numbering resources.

Permitted sharing by M2M service providers of E.212 MNCs

Again, given the lack of any specific provision in the Electronic Communications Networks and Services Act, ENS takes the view that Danish legislation does not prohibit the shared use of MNCs.

Fees for the assignment and/or use of E.164 mobile numbers

Fees are levied for the assignment and use of E.164 mobile numbers. S25 of the Electronic Communications Networks and Services Act provides that fees for numbering resources are fixed on an annual basis in the Finance Act, and a current scale of charges is published by the regulator on its website[69]. The current annual fee for a 12-digit number is 0.02kr.

[68] See s6 of https://www.retsinformation.dk/forms/R0710.aspx?id=136741

[69] See https://ens.dk/ansvarsomraader/telefoni/numre/nummerafgifter (Danish language only).

Differential treatment of applicable fees if mobile numbers are used for M2M services

The annual fee for a 12-digit number of the type allocated for use by M2M services is considerably lower than that for a comparable eight-digit mobile number; 0.02kr for the former compared with 2kr for the latter, representing a factor of 100.

Fees for the assignment and/or use of E.212 MNCs

Fees are levied for the assignment and use of E.212 MNCs. The current annual fee for an MNC is 20,000kr.

Differential treatment of applicable fees if MNCs are used for M2M services

In its response to the November 2016 CEPT WG NaN questionnaire, ENS states that there is no difference in the applicable fees for E.212 MNCs where they are used for M2M services.

Permitted use of overseas E.164 mobile numbers and/or E.212 MNCs on a permanent extra-territorial basis for M2M services

In its response to the November 2016 CEPT WG NaN questionnaire, ENS notes that this issue is not regulated in the Danish Electronic Communications Networks and Services Act. Accordingly, Danish legislation does not prohibit the extra-territorial use of numbering resources from another country.

Do Number Portability requirements apply to resources used for M2M services?

Number Portability requirements are set out in Part 7 of the Electronic Communications Networks and Services Act, s26 (2) of which prescribes that *Providers of electronic communications networks or services shall meet all requests from other providers of electronic communications networks or services for establishing agreements to transfer subscriber numbers for the purpose of enabling number portability as requested by an end-user*.

The same requirements for NP apply to M2M services as to other services for which number resources have been provided.

7.2.3 Detailed Provisions – Numbering for OTT

Formal Definition of OTT

The Danish regulator has yet to publish a formal definition of what may or may not constitute an OTT service.

Permitted Use of Numbering Resources for OTT

The use of both E.164 mobile numbers and E.212 Mobile Network Codes (MNCs) is permitted for OTT applications.

Types of E.164 numbers permitted for use OTT services

There is no specific number range for OTT services in the Danish numbering plan. In general, both mobile and fixed numbers can be used, dependent on the exact nature of the application being offered by the service provider.

Assignment of E.212 MNCs for OTT services to undertakings other than MNOs or MVNOs

Numbering resources may be assigned to any party deemed by the regulator to be a legitimate provider of telecommunications networks or services. There is no specific differentiation in terms of eligibility between MNOs, MVNOs, resellers, etc.

Fees for the assignment and/or use of E.164 mobile numbers

Fees are levied for the assignment and use of E.164 mobile numbers. The current annual fees are set at 2kr for eight-digit numbers and 0.02kr for 12-digit numbers.

Differential treatment of applicable fees if mobile numbers are used for OTT services

In its response to the November 2016 CEPT WG NaN questionnaire, ENS states that there is no difference in the applicable fees for E.164 mobile numbers where they are used for OTT services.

Fees for the assignment and/or use of E.212 MNCs

Fees are levied for the assignment and use of E.212 MNCs. The current annual fee for an MNC is 20,000kr.

Differential treatment of applicable fees if MNCs are used for OTT services

In its response to the November 2016 CEPT WG NaN questionnaire, ENS states that there is no difference in the applicable fees for E.212 MNCs where they are used for OTT services.

Do Number Portability requirements apply to resources used for OTT services?

The established requirements for Number Portability as set out in s26 (2) of the Electronic Communications Networks and Services Act applies equally in the case of OTT services as for any other electronic communications services for which number resources have been provided.

7.3 Germany

7.3.1 Regulatory Background

Numbering resources in Germany are administered by the Federal Network Agency (Bundesnetzagentur - BNetzA), the national regulatory office for electricity, gas, telecommunications, post and railway markets. Underpinning legislative provisions are contained within the Telecommunications Act (TKG)[70], the Numbering Plan for the Numbering Space for Public Telecommunications[71], and the Numbering Plan for Numbers for Mobile Services[72].

[70] An English-language transcript of the 2004 version of this law may be obtained online at http://www.cgerli.org/fileadmin/user_upload/interne_Dokumente/Legislation/telekommunkationsgesetz-en.pdf

[71] See https://www.bundesnetzagentur.de/SharedDocs/Downloads/EN/BNetzA/Areas/Telecommunications/NumberManagement/numbering_space/NP_numbering_space_2016.pdf?__blob=publicationFile&v=1

[72] See https://www.bundesnetzagentur.de/SharedDocs/Downloads/EN/BNetzA/Areas/Telecommunications/NumberManagement/MobileServices/Mobileservices_Numbering%20Plan200913.pdf?__blob=publicationFile&v=1

In March 2011, the BNetzA published a consultation entitled *The Effects of Changes in Machine-to-Machine (M2M) Communication on Numbering*[73] and asked for written comments. Based on evaluation of these comments, BNetzA prepared a draft numbering plan and application procedure for numbers for M2M applications. In the event, however, a further public consultation in June 2013[74] indicated that most stakeholders seemed to prefer using numbers from the normal mobile ranges for M2M applications. BNetzA therefore concluded that there was currently no need for a separate dialling plan for M2M communication, though keeping the matter under review with the ability to deploy swiftly special numbers for M2M applications if and when needed[75].

On 15th June 2016, the BNetzA published new rules on the use of IMSI numbers for M2M services. These (Decrees No. 32/2016[76] and No. 33/2016[77]) permit the use of German IMSIs for M2M services in other countries, and the use of extraterritorial (foreign) IMSIs in Germany. A third decree (No. 34/2016[78]) amended previous assignments of IMSIs in order to remove potential conflicts with the new rules, so creating a unified legal framework for all M2M services based on IMSIs.

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[73] *Auswirkungen der Entwicklungen bei der Machine-to-Machine (M2M) Kommunikation auf die Nummerierung*, Communication 139/2011 in the BnetzA Official Journal No. 5/2011 of 9th March 2011

[74] Communication 136/2013, Official Journal 7/2013 of 24 April 2013

[75] Source: https://www.bundesnetzagentur.de/cln_1432/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Nummerierung/Rufnummern/M2M/M2M_node.html;jsessionid=935375159AB80F1E30DE81015DEC6021

[76] German-language version at http://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Nummerierung/TechnischeNummern/IMSI/IMSI_NP.pdf?__blob=publicationFile&v=2

[77] German-language version at http://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Nummerierung/TechnischeNummern/IMSI/IMSI_exterritNutzung.pdf?__blob=publicationFile&v=1

[78] German-language version at http://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Nummerierung/TechnischeNummern/IMSI/IMSI_Tw_Widerruf.pdf?__blob=publicationFile&v=2

7.3.2 Detailed Provisions – Numbering for M2M

Formal Definition of M2M

A formal definition of M2M communications is provided within S6 of BNetzA Order No.33/2016[79]:

> *the predominantly automated exchange of information between technical devices such as machines, vending machines, vehicles or measuring equipment (e.g. electricity, gas and water meters) or between the devices and a central data processing unit ...*
> *Communications can be either wire-based or wireless. A human is not usually involved in the communications, although limited human involvement does not preclude classification as M2M communications.*
> *If limited human involvement is part of a service, this does not preclude classification as M2M communications for the purposes of the numbering plan at least in the following cases:*
>
> - *activation/operation/control/monitoring of an M2M application or an M2M device using technical equipment such as a computer, smartphone, tablet, etc. by a human in either a private (e.g. smart home) or an industrial environment;*
> - *activation of an application that enables individual communication in the sense of a preselected point-to-point communication but not a call to a freely selectable number. Examples of this are eCalls in vehicles, private emergency calls in lifts and/or vehicles, and concierge services in vehicles.*
>
> *This list is not exhaustive and is without prejudice to an assessment of new business models.*

Permitted Use of Numbering Resources for M2M

The use of both E.164 mobile numbers and E.212 Mobile Network Codes (MNCs) is permitted for M2M applications[80].

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[79] German-language version at https://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Nummerierung/TechnischeNummern/IMSI/IMSI_exterritNutzung.pdf;jsessionid=96CD8B47AB58E3A6028DE41A6D9107E0?__blob=publicationFile&v=1

[80] See https://www.bundesnetzagentur.de/EN/Areas/Telecommunications/Companies/NumberManagement/nu

Assignment of E.164 mobile numbers and/or E.212 MNCs to undertakings other than MNOs or MVNOs

E.164 mobile numbers may be assigned to entities other than MNOs or MVNOs providing that they meet the overall eligibility requirements set out in s3 and s4.2 of the mobile numbering plan. Where an applicant does not presently offer a service eligible for the primary assignment of E.164 mobile numbers but expects to do so within a 12-month period, an application for numbers may be filed in advance.

For the assignment of E.212 MNCs, S4.2 of Decree No. 32/2016[81] of 15 June 2016 specifically states that direct (Primary) assignments of IMSI block resources may only be made to MNOs, MVNOs and Mobile Virtual Network Enablers (MVNEs). Applications may be made up to six months in advance by parties expecting to fulfil the necessary eligibility criteria within that time, but any allocation resulting may be withdrawn if the applicant does not provide proof of their having attained eligibility within six months of the initial award. Any subsequent assignments will be contingent upon a utilisation level of at least 90% having been reached for currently assigned resources. Secondary assignments (i.e. to end-users) may be made either by the primary assignee or by a third party authorised by the primary assignee, and must commence within 180 days of the relevant IMSI block being allocated.

Availability of dedicated E.164 mobile number range for M2M services

There is presently no dedicated E.164 mobile number range for M2M services, previous public consultations having indicated no significant demand due to availability of numbers within the normal mobile service ranges.

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mbermanagement_node.html (E164) and https://www.bundesnetzagentur.de/EN/Areas/Telecommunications/Companies/NumberManagement/TechnicalNumbers/InternationalMobileSubsciber/internationalmobilesubsciber_node.html (E212)

[81] German-language version at http://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Nummerierung/TechnischeNummern/IMSI/IMSI_NP.pdf?__blob=publicationFile&v=2

Permitted use of national E.164 mobile numbers and/or E.212 MNCs to be used on a permanent extra-territorial basis for M2M services

The use of both national E.164 mobile numbers and E.212 MNCs on a permanent extra-territorial basis for M2M services is permitted.

In its response to the November 2016 CEPT WG NaN questionnaire, BNetzA states that the extra-territorial use of German E.164 numbers overseas is presently tolerated by administrative practice, and a corresponding adoption of a separate administrative order accompanying the numbering plan on mobile numbers is under way. However, the permission may be revoked in certain instances. Moreover, contrary to IMSIs, the use of German mobile numbers overseas is conditional upon a notification of the extra-territorial use to BNetzA.

Until 2016, German E.212 MNCs could only be used on an extraterritorial basis during travel (temporary roaming). On 15 June 2016, however, the BNetzA published new rules on the use of IMSI numbers for M2M services. The first of these (Decree No. 32/2016) permitted the use on a permanent basis of German IMSIs for M2M services in other countries, in the form of a derogation from the general principle by which the extra-territorial use of German numbers is held inadmissible. S6.1.1 of the Decree defined extraterritorial use as being by way of permanent activation of the IMSIs in a foreign telecommunications network, or by way of permanent international roaming. Use of German IMSIs abroad via temporary roaming was not considered to constitute extra-territorial use of IMSIs and continues unchanged.

S6.2 of the Decree made provision for the extraterritorial use of IMSIs in connection with M2M communications to be revoked, should it consider that such use were to constitute a detriment either to the public interests (e.g. public safety, number shortages) or to the rights of third parties (e.g. competition or consumer protection considerations). Any such revocation could be applied in individual cases, for specific business models, or generally. In the case of any such revocation, BNetzA would be required to determine an appropriate timeframe in which existing applications were to cease.

The Decree also noted that the decision of the German authorities to permit extra-territorial use of German IMSIs does not necessarily mean that the use of these numbers overseas is necessarily permitted under the laws of the foreign countries concerned. It was emphasised that the assignment holder and/or the user of the number bore responsibility for clarifying local requirements for the extra-

territorial use of German IMSIs and complying with them. Holders of IMSI block assignments were advised to draw the attention of contractual partners to this.

Permitted sharing by M2M service providers of E.212 MNCs

In its response to the November 2016 CEPT WG NaN questionnaire, BNetzA states that sharing of E.212 MNCs is not permitted, such resources only being assigned to MNOs and MVNOs[82].

Fees for the assignment and/or use of E.164 mobile numbers

Fees for the use of numbering resources are set by the Telecommunications Fee Regulation (TNGebV)[83].

For each block of E.164 mobile numbers, an assignment fee of €335 is charged. Numbers are allocated in blocks of 1 million, 10 million or 100 million dependent upon the number range in question[84].

Differential treatment of applicable fees if mobile numbers are used for M2M services

In its response to the November 2016 CEPT WG NaN questionnaire, BNetzA states that there is no difference in the applicable fees for E.164 mobile numbers where they are used for M2M services.

Fees for the assignment and/or use of E.212 MNCs

According to fee scales published on the BNetzA website[85], a charge of €178 is levied for the assignment of an operator code. A charge of €120 is made for the assignment of a block of 10,000,000 international identifiers for mobile participants (IMSI).

[82] Though S4.2 of Decree No. 32/2016 of 15 June 2016 specifically states that direct (Primary) assignments of IMSI block resources may also be made to Mobile Virtual Network Enablers (MVNEs) and, for test purposes only, suppliers of mobile communications technologies.

[83] See http://www.gesetze-im-internet.de/bundesrecht/tngebv/gesamt.pdf (German language only)

[84] S2 Mobile Numbering Plan

[85] See http://www.gesetze-im-internet.de/bundesrecht/tngebv/gesamt.pdf (German language only)

Differential treatment of applicable fees if MNCs are used for M2M services

In its response to the November 2016 CEPT WG NaN questionnaire, BNetzA states that there is no difference in the applicable fees for E.212 MNCs where they are used for M2M services.

Permitted use of overseas E.164 mobile numbers and/or E212 MNCs on a permanent extra-territorial basis for M2M services

The use of overseas E.164 mobile numbers and E.212 MNCs on a permanent extra-territorial basis for M2M services is permitted.

In its response to the November 2016 CEPT WG NaN questionnaire, BNetzA states that the extra-territorial use of overseas E.164 numbers in Germany is presently tolerated by administrative practice, and a corresponding adoption of a separate administrative order accompanying the numbering plan on mobile numbers is under way. However, the permission may be revoked in certain instances. Moreover, contrary to IMSIs, the use of foreign mobile numbers in Germany is conditional upon a notification of the extra-territorial use to BNetzA.

For E.212 MNCs, the use in Germany of overseas IMSIs on a permanent basis for M2M services was authorised by Decree No. 33/2016[86] of 15 June 2016. The Decree mirrors the terms of that facilitating the use of German IMSIs abroad, in terms of the definition of 'permanent extra-territorial use' covering the use of foreign IMSIs in Germany by way of permanent activation in a German telecommunications network or by way of permanent international roaming. The temporary use of foreign IMSIs during travel (temporary roaming) was not deemed to fall within this definition, already being permitted under existing legislation. Also, as with the use of German IMSIs abroad, BNetzA reserved the right to revoke the right to use overseas IMSIs in Germany should it consider such an action to be in the public interest or necessary to protect the rights of third parties. BNetzA has also emphasised that the permission to use extraterritorial IMSIs in Germany does not exempt service providers from other rules of German telecommunications law that may be applicable, such as any obligation to register as a

[86] German-language version at http://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Nummerierung/TechnischeNummern/IMSI/IMSI_exterritNutzung.pdf?__blob=publicationFile&v=1

telecommunications service provider in Germany[87], nor from any legal requirements imposed by the overseas country issuing the IMSI with regard to the use of such resources on an extra-territorial basis.

Do Number Portability requirements apply to resources used for M2M services?

BNetzA Communication No 770/2016 of 15th June 2016[88] addresses the issue of number portability obligations for numbers allocated to M2M services. The position of the BNetzA in this regard appears to be that, While it does not see that number portability is essential for M2M applications, it cannot provide an exemption from the overriding requirements of the Telecommunications Law in this regard[89]. Accordingly, While it will not require providers of M2M services to guarantee number portability when requesting numbering resources, neither can it indemnify such parties against requests for number portability from other parties nor claims for statutory compensation in the event of such requests not being fulfilled.

7.3.3 Detailed Provisions – Numbering for OTT

Formal Definition of OTT

There is no official definition of OTT in German telecommunications law. At present, BNetzA relies upon the classification of OTT communication (OTT-1) and OTT content (OTT-2) previously advanced by BEREC, though this may change contingent upon the adoption by the European Commission in its proposal for a European Electronic Communications Code of new terminology covering OTT services

Permitted Use of Numbering Resources for OTT

In its response to the November 2016 CEPT WG NaN questionnaire, BNetzA states that E.164 mobile numbers may be used in conjunction with the provision of OTT services. While it would appear that the use of E.212 MNCs for OTT applications is not specifically prohibited, BNetzA notes the following requirement set out in the Numbering Plan for IMSIs: "IMSIs are used as a form of unique international

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[87] See s6 Telecommunications Act

[88] See https://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Nummerierung/Rufnummern/M2M/M2M_Portierbarkeit_Rufnummern.html?nn=265850 – German-language document only

[89] A situation which might be changed if and when dedicated M2M numbering ranges are adopted?

identification for subscribers and terminal equipment in public telecommunications networks. They cannot be dialled by subscribers from public telecommunications networks", and questions what role IMSIs could play for OTT services.

Types of E.164 numbers permitted for use with OTT services

In principle, all types of E.164 numbers are available for use in connection with OTT services, providing that the nature of the service provided complies with any conditions set against that numbering type in the numbering plan.

Assignment of E.212 MNCs for OTT services to undertakings other than MNOs or MVNOs

E.212 MNCs may only be allocated to MNOs, MVNOs or MVNEs.

Fees for the assignment and/or use of E.164 mobile numbers

The Telecommunications Fee Regulation (TNGebV) specifies an assignment fee of €335 for each block of E.164 mobile numbers.

Differential treatment of applicable fees if mobile numbers are used for OTT services

In its response to the November 2016 CEPT WG NaN questionnaire, BNetzA states that there is no difference in the applicable fees for E.164 mobile numbers where they are used for OTT services.

Fees for the assignment and/or use of E.212 MNCs

According to fee scales published on the BNetzA website[90], a charge of €178 is levied for the assignment of an operator code, with a further charge of €120 made for the assignment of a block of 10,000,000 international identifiers for mobile participants (IMSI).

Differential treatment of applicable fees if MNCs are used for OTT services

There is no provision for differential pricing to be applied in the case of E.212 MNCs being assigned for OTT use, should such an assignment ever occur.

[90] See http://www.gesetze-im-internet.de/bundesrecht/tngebv/gesamt.pdf (German language only)

Do Number Portability requirements apply to resources used for OTT services?

Standard Number Portability requirements apply to OTT services.

7.4 The Netherlands

7.4.1 Regulatory Background

Numbering policy in the Netherlands is implemented by the Authority for Consumers & Markets (ACM) and codified in the Telecommunications Act of 19 October 1998[91] and the Numbering Plan for Telephone and ISDN services[92], as amended by various Ministerial Decisions and Decrees. There is also a Numbering Plan for International Mobile Subscription Identities (IMSIs)[93].

Decision No. ETM/TM/11155637 of the Minister of Economic Affairs, Agriculture and Innovation of 14th November 2011[94] amended the national numbering plan to provide a dedicated number range of automated (M2M) applications. Draft versions of the Decision were opened to public consultation in 2010 and 2011, the results of which indicated public and industry support for the creation of a new numbering space for M2M applications. The definitive version of the Decision introduced a new range of 12-digit non-geographic numbers to support both fixed-line and mobile M2M applications, to be phased-in to use between March 2011 and March 2013.

[91] An English transcript of the Act is available via https://www.government.nl/documents/policy-notes/2012/06/07/dutch-telecommunications-act, but only updated to June 2012.

[92] Current version at https://www.government.nl/binaries/government/documents/annual-reports/2016/02/16/numbering-plan-telephony-and-isdn-services/numbering-plan-telephony-and-isdn-services.pdf, of which Articles 1c and 1d have specific reference to M2M activities.

[93] Referenced by ACM as Government Gazette [Stcrt.] 1999, 15; most recently amended by decree of 22 January 2009 (Government Gazette 1588), available on-line at http://wetten.overheid.nl/BWBR0010199/2014-03-13 but in Dutch only.

[94] See https://www.government.nl/documents/annual-reports/2016/02/16/decree-change-of-telephone-and-isdn-services-numbering-plan-for-m2m-applications

Decree No. ETM/TM/ 14024019 of the Minister of Economic Affairs of 3rd March 2014[95] amended the IMSI numbering plan with regard to the use of IMSIs by private networks. The provisions of the decree included measures to facilitate the use of shared MNCs, chiefly the assignment of specified ranges of MNCs for this purpose. The purpose behind this was to aid switching between service providers by commercial users of large-scale M2M applications, notably those reliant upon embedded SIM cards which cannot easily be replaced to facilitate connection to an alternative network.

7.4.2 Detailed Provisions – Numbering for M2M

Formal Definition of M2M

Article 1(j) of the Numbering Plan as amended by the Ministerial Decision of 14th November 2011 defines an M2M service as:

> *electronic communications service for an automated application: electronic communications service where the number is normally not called by the user or is called automatically*

In Note 8 to the Decision, the regulator noted that a deliberately broad definition of M2M was adopted in order to simplify matters and to allow for the easy inclusion of future new M2M services which might otherwise fall outside a more closely-drawn definition. The decision was thus made to draw up the definition on the basis of the common characteristics shared by M2M applications, namely that most calling operations will be performed automatically and without the need for human intervention, thus obviating the need for user-friendly and recognisable numbers.

Note 3 to the Decision suggests four categories of M2M service, namely:

- **Machine-to-Machine**; applications in which devices function autonomously and communicate automatically with each other, such as smart energy meters, blood pressure monitors, stock management in vending machines, navigation devices, GPS trackers, mobile internet on laptops using 'dongles' and e-readers;

[95] Seehttps://www.government.nl/documents/annual-reports/2016/02/16/decree-change-of-imsi-number-plan-for-private-networks

- **Machine-to-Human**; autonomously operating devices establishing connections in order to communicate with humans, such as security or alarm systems which call a security company automatically in the event of a break-in or other emergency, and cars which automatically call an emergency number (E-call) after an accident, transmitting the car's details and location;
- **Human-to-Machine**; applications in which a person establishes a connection with an autonomously operating device, notably devices which can be operated remotely such as the remote setting of a thermostat or the adjustment of a security camera. In practice, the communication will go through an internet application on a computer or smartphone and not through a voice connection or text message;
- **Human-to-Human**; applications involving voice connections between people, but where the number is normally called automatically, for instance a telephone application in a car which can be used to call for assistance in the event of a breakdown, the connection to the assistance service being initiated by pressing a single button.

Permitted Use of Numbering Resources for M2M

The use of both E.164 mobile numbers and E.212 Mobile Network Codes (MNCs) is permitted for M2M applications.

Assignment of E.164 mobile numbers and/or E.212 MNCs to undertakings other than MNOs or MVNOs

In its response to the November 2016 CEPT WG NaN questionnaire, ACM notes that M2M numbering resources are only assigned to providers of Electronic Communications Services (ECS).

In addition to MNOs and MVNOs, E.212 MNCs in The Netherlands may be assigned to:

- Mobile Virtual Network Enablers (MVNEs) and Aggregators (MVNAs);
- Other entities with connectivity requirements, e.g. eCall, connected cars, smart metering, M2M/IoT services, Private Virtual Network Operators (PVNOs);
- Entities with interoperability requirements, e.g. SMS service providers;
- Entities for specific use cases (e.g. GSM-R, Government networks.)

Availability of dedicated E.164 mobile number range for M2M services

Under Article 1c of the Netherlands National Numbering Plan[96], a specific numbering range (0970) is used as the default resource for the 'provision of an electronic communication service for an automated application'. This is a 12-digit non-geographic range catering for both fixed-line and mobile applications. The following 0971-0978 ranges are held in reserve against depletion of the 0970 range, and will be allocated as and when considered necessary.

Reasons for choosing this range for M2M applications were stated to include the fact that the previously-unallocated 09 range has the largest free capacity in the numbering plan and so offers considerable future potential for expansion of M2M services. In a similar vein, as the vast majority of M2M calls are made via automated processes, there is a reduced requirement for numbers to be 'user friendly', so permitting the use of numbers with more than 12 digits, creating a potential 100-million number pool[97].

In order to prevent depletion of existing number ranges, new 0970 numbers for M2M applications were to be made available from 1 December 2011, with the use of other numbers being gradually phased-out. For large-scale applications, the use of 0970 numbers was to become compulsory from 1 March 2013. For small-scale applications, the adoption deadline was delayed to 1 March 2015 in order to allow more time for providers to adapt supporting administrative systems, though with limits on the quantities of 10-digit user-friendly numbers allocated to M2M use from 1st March 2013, such new allocations ceasing from 1st December 2013[98].

The series 0979 (which does not form part of the numbering plan) is not assigned and is kept free for network internal use. This primarily relates to applications within a single company intended for

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[96] See https://www.government.nl/binaries/government/documents/annual-reports/2016/02/16/numbering-plan-telephony-and-isdn-services/numbering-plan-telephony-and-isdn-services.pdf

[97] Even longer numbers (e.g. 14 digits) are theoretically possible but not adopted for M2M applications in the Netherlands at this stage due to worries over potential complications and costs related to the need to upgrade some routing and billing systems - see s4.3 of Decision of 14 November 2011

[98] Further exemptions apply to the ranges 067, 0800, 084, 087 and 090, for which there was prescribed no phase-out period. It was noted, however, that these numbers may only be used for specifically described services and by their nature are not very suitable for large-scale M2M use.

internal management processes, with no communication with third parties. Such applications, which may be large-scale, will therefore only use one landline or mobile network, because there is no need for cross-network communication. Accordingly, each operator can draw up and maintain their own internal numbering plan for such applications, as numbers only need to be unique within that particular network and not co-ordinated with other operators. Conversely, operators need to have confidence that resources used for this purpose will not be affected by future revisions to the national numbering scheme with concomitant disruptions and/or internal costs[99].

Permitted use of national E.164 mobile numbers and/or E.212 MNCs to be used on a permanent extra-territorial basis for M2M services

In its response to the November 2016 CEPT WG NaN questionnaire, ACM states that permanent extra-territorial use of national E.164 mobile numbers (within the dedicated 097 range) and E.212 MNCs for M2M services is permitted, in accordance with CEPT recommendations. As the use of numbers for M2M services is effectively restricted to the 097 range with its high degree of spare capacity, ACM does not consider that the extraterritorial use of national numbers in this way should result in any problems connected with scarcity of resources.

Permitted sharing by M2M service providers of E.212 MNCs

Decree No. ETM/TM/ 14024019 of the Minister of Economic Affairs of 3rd March 2014[100] introduced amendments to the IMSI numbering plan to facilitate the use of shared MNCs. Two blocks of MNCs, 204 90xx and 204 91xx, were assigned specifically for shared use by large-scale M2M users (or co-operatives of M2M users), with the ability to create multiple IMSI sub-ranges which could be assigned to participants, each of which would then be free to negotiate their own airtime contracts with an MNO/MVNO of their choice. Technical provisioning was envisaged using a proxy Home Location Register (HLR) to facilitate routing of traffic While facilitating direct commercial and financial

[99] see s4.2 of Decision of 14 November 2011

[100] Seehttps://www.government.nl/documents/annual-reports/2016/02/16/decree-change-of-imsi-number-plan-for-private-networks

relationships between service users and airtime providers[101]. The Decree foresaw[102] that such a body could be created within the market or public sector, providing services comparable to those of an MVNO, subject to the proviso that these are not publicly provided electronic communication services, but services that are supplied in a private commercial environment.

Although the two MNC blocks assigned for shared use are functionally similar, the 204 90xx block is allocated for commercial usage and the 204 91xx for institutional (non-commercial usage). The reasoning behind this was to facilitate the operation of Government-funded or other public sector institutions looking to provide shared MNC services on a non-commercial basis, e.g. an organisation which is legally required to facilitate telemetric communication with energy meters. The provision of separate shared MNC ranges for each of these two segments was held to enable the necessary infrastructures to be developed completely independently of one another, removing commercial pressures and uncertainties from organisations whose remit is to satisfy a public need While simultaneously guarding against any suggestion that publicly-financed entities may be competing unequally with private-sector equivalents.

Under s4.2b and s12.2(6) of the Telecommunications Act, the ACM is authorised to supervise the conclusion of agreements between assignees of shared MNCs, and may, upon the request of one or more of those parties, prescribe rules for concluding these agreements.

Fees for the assignment and/or use of E.164 mobile numbers

The following fees are charged for the assignment and use of E.164 mobile numbers[103]:

- Assignment fee of €20 per 1,000-number block;
- Annual fee of €6 per 1,000-number block.

[101] An overview is provided in s3.2 and s3.4 of the Decree. Also see the Stratix Consulting presentation *Using a shared MNC for M2M* by Paul Brand and Alexander ter Haar (http://www.stratix.nl/media/media/documents/stratix%202013%20-%20shared%20mnc%20for%20m2m.pdf), referenced by ACM in its response to the November 2016 CEPT WG NaN questionnaire

[102] S3.2 of Decree No. ETM/TM/ 14024019 3rd March 2014, final paragraph

[103] Source: https://www.acm.nl/nl/onderwerpen/telecommunicatie/telefoonnummers/vergoedingen-toekennen-en-toezicht-nummers/tariefklasse-2/, Sub-category B

Differential treatment of applicable fees if mobile numbers are used for M2M services

Typically, fees charged for the use of E.164 mobile numbers for M2M services are much cheaper than for similar numbers for other uses, but this is dependent upon the number range used.

For the dedicated 0970 M2M range, the following fees are charged[104]:

- Assignment fee of €0.44 per 1,000-number block;
- Annual fee of €0.11 per 1,000-number block.

For the other ranges for which M2M usage is permitted under Article 1c (2) of the Dutch Numbering Plan, the following fees apply:

Number range	Assignment fee	Annual fee
067	€647/number	€121/number
0800	€40-€79/number	€16-€30/number
084	€20/1,000 numbers	€20/1,000 numbers
087	€20/1,000 numbers	€20/1,000 numbers
090	€40-€79/number	€16-€30/number

Fees for the assignment and/or use of E.212 MNCs

The following fees are charged for the assignment and use of E.212 MNCs[105]:

- Assignment fee of €647 per code;
- Annual fee of €121 per code.

Differential treatment of applicable fees if MNCs are used for M2M services

The ACM website does not indicate any price differential where MNCs are used in connection with the provision of M2M services.

[104] Source: https://www.acm.nl/nl/onderwerpen/telecommunicatie/telefoonnummers/vergoedingen-toekennen-en-toezicht-nummers/tariefklasse-2/, Sub-category F

[105] Source: https://www.acm.nl/nl/onderwerpen/telecommunicatie/telefoonnummers/vergoedingen-toekennen-en-toezicht-nummers/tariefklasse-2/, Sub-category A

Permitted use of overseas E.164 mobile numbers and/or E212 MNCs on a permanent extra-territorial basis for M2M services

In its response to the November 2016 CEPT WG NaN questionnaire, ACM states that permanent extra-territorial use within the Netherlands of overseas E.164 mobile numbers and E.212 MNCs for M2M services is permitted, in accordance with CEPT recommendations.

Do Number Portability requirements apply to resources used for M2M services?

Standard portability rules apply to all 097-series M2M number ranges[106].

7.4.3 Detailed Provisions – Numbering for OTT

Formal Definition of OTT

ACM has confirmed that there is no formal regulatory definition for OTT in The Netherlands. In its response to the November 2016 CEPT WG NaN questionnaire, however, ACM provided answers on the basis of OTT services being those where the provider does not deliver the access networks to the end user.

Permitted Use of Numbering Resources for OTT

The use of both E.164 mobile numbers and E.212 Mobile Network Codes (MNCs) is permitted for OTT applications, so long as the service concerned meets the relevant requirements of the National Numbering Plan.

Types of E.164 numbers permitted for use with OTT services

The National Numbering Plan defines the 06760 10-digit non-geographic range as being dedicated for access to IP-based networks and services. Beyond that, there do not appear to be any specific ranges allocated for OTT use. ACM confirms there is no discrimination in the allocation of E.164 numbers between OTT applications and other permitted usages, provided that the OTT service meets all relevant requirements.

[106] Excluding the internal network 0979 range

Assignment of E.212 MNCs for OTT services to undertakings other than MNOs or MVNOs

In its response to the November 2016 CEPT WG NaN questionnaire, ACM drew attention to the ACM's Decision of 22nd August 2016 in response to the objection of Aspider Solutions Netherlands BV against the ACM's previous decision of 10th March 2016 to reject Aspider's application for an MNC[107].

Aspider, an MVNE, had previously been allocated an MNC but in January 2016 had requested that this be transferred to an MVNO, Wyless Nederland, a request which was granted by ACM. Aspider subsequently requested the issue of a new MNC in its own name, but ACM declined this request, arguing that it was not a unique network in its own right and was in any case already identified by the MNC (No.23) which it had transferred to Wyless Nederland. Aspider objected to this decision and appealed, claiming that its network and that of Wyless were separate, that a virtual infrastructure still qualified as a public communications network (noting that the advance of Network Function Virtualisation (NFV) means networks can exist without physical equipment), and claiming that its virtual network was sufficiently unique to justify its own MNC.

In the light of the representations made by Aspider, ACM determined that the grounds for deciding that Aspider did not qualify for an MNC were invalid, and that the previous Decision should be revoked.

Accordingly, ACM has modified its criteria for granting MNCs, with providers of virtual networks as well as physical ones now being able to secure MNCs, so long as the virtual network is completely separate and independent from the physical network. In its commentary to the Decision, ACM noted that the availability of MNCs to virtual operators would allow them to issue their own SIM cards and, in this way, maximise independence from other wholesale providers. Conversely, with 36 of the 90 available two-digit MNCs already issued, and demand for new MNCs expected to increase as further virtual operators take advantage of the opportunity to secure their own code, ACM drew attention to the possible risk of future shortage in MNC resources, a matter which it said it intended to bring to the attention of the ITU.

[107] Transcript available at https://www.acm.nl/nl/download/publicatie/?id=16212 (Dutch language only)

Fees for the assignment and/or use of E.164 mobile numbers

The following fees are charged for the assignment and use of E.164 mobile numbers:

- Assignment fee of €20 per 1,000-number block;
- Annual fee of €6 per 1,000-number block.

Differential treatment of applicable fees if mobile numbers are used for OTT services

The ACM website does not indicate any price differential where mobile numbers are used in connection with the provision of OTT services.

Fees for the assignment and/or use of E.212 MNCs

In its response to the November 2016 CEPT WG NaN questionnaire, ACM did not answer this question. The ACM website[108], however, indicates that the following fees are charged for the assignment and use of E.212 MNCs:

- Assignment fee of €647 per code;
- Annual fee of €121 per code.

Differential treatment of applicable fees if MNCs are used for OTT services

There is no differentiated pricing for E.212 MNCs when used for OTT applications against other usages.

Do Number Portability requirements apply to resources used for OTT services?

InterConnect is not aware of any modification to or exemption from standard portability rules for numbering resources used in conjunction with OTT services.

[108] Source: https://www.acm.nl/nl/onderwerpen/telecommunicatie/telefoonnummers/vergoedingen-toekennen-en-toezicht-nummers/tariefklasse-2/, Sub-category A

7.5 Norway

7.5.1 Regulatory Background

Telecommunications regulatory issues in Norway – including the management of numbering systems and resources – are the responsibility of the Norwegian Communications Authority (Nasjonal Kommunikasjonsmyndighet - Nkom). Legislative provisions relating to numbering issues are chiefly contained in the 2003 Electronic Communications Act 2003[109], the 2004 Regulations on Electronic Communications Networks and Services (Ecom Regulations)[110], the 2004 Numbering Regulation[111], and the General Norwegian Numbering Plan for Telephony[112].

In March 2006, the regulator promulgated a Decision reserving the eight-digit 58 and 59 non-geographic ranges for M2M. In November 2008, it was decided that the 58 range should be expanded to 12 digits and be reserved for M2M in addition to the existing eight-digit 59 range. The use of 12 digit numbers for M2M entered into force from the beginning of 2010.

In September 2014, Nkom undertook a public consultation exercise regarding the assignment and use of numbers for land mobile services[113]. In December of that same year, the regulator published a paper[114] outlining principles applying to the assignment and use of numbers for IP-based voice services for mobile terminals; so-called mVoIP (mobile Voice over IP). This permitted the assignment and use of eight-digit mobile numbers for mVoIP services where these could be considered as full mobile telephone services. This required that the service overall must be able to offer:

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[109] See http://eng.nkom.no/laws-and-rules/_attachment/12665?_download=true&_ts=1453bfacd60

[110] See http://eng.nkom.no/laws-and-rules/regulations/_attachment/15082?_download=true&_ts=1508977f42f

[111] See http://eng.nkom.no/laws-and-rules/regulations/_attachment/9949?_download=true&_ts=15709d93465

[112] See http://eng.nkom.no/market/numbering/e.164-numbering-plan/general-norwegian-numbering-plan-for-telephony-etc.e.164 and http://www.nkom.no/npt/numsys/E.164.pdf

[113] See http://eng.nkom.no/market/numbering/numbering/numbers-for-land-mobile-services Consultation document in Norwegian only

[114] *Assignment and use of numbers for land mobile services (the 4 and 9 series) for mVoIP and other new services*, 11 December 2014, available on-line at http://eng.nkom.no/market/numbering/numbering/numbers-for-land-mobile-services/_attachment/18107?_download=true&_ts=14d56a53da3

- Access to incoming and outgoing voice services using numbers from the national number plan;
- Ordinary SMS functionality;
- Data services;
- End-user mobility equivalent or close to that offered by ordinary mobile telephone services. This means that when the terminal is outside of Wi-Fi range, the service must also offer the user the option of initiating or receiving calls over land mobile networks (e.g. by using 3G/4G data transmission).

At the end of September 2016, Nkom published a further consultation document, this time relating to matters concerning possible measures to ensure sufficient future numbering resources[115]. The consultation document embraced (amongst others) the questions of numbering resources for both M2M and OTT applications. One evident concern was the proliferation of multiple mobile subscriptions and the resulting impact on availability of mobile numbers, especially with the implementation of systems and services able to support multiple mobile numbers from a single subscription. In this regard, Nkom noted the importance of operators facilitating the greatest possible use of the dedicated M2M number ranges for such applications, even in cases where speech could form part of the service. A number of questions were posed, including:

- What if any obstacles exist to the wider use of the dedicated 12-digit M2M numbering resource, what changes need to be made to address these, and would be the likely cost implications and implementation timeframe?
- Should providers of OTT services be assigned a dedicated number series for such applications? If so; why and what type of number? What criteria should be set for eligibility?
- What might be the implications of a possible wider transition to nine-digit numbering plan in terms of technicalities, likely cost implications and implementation timeframe, and consequences for end users?

The results of the consultation (which closed in November 2016) have yet to be published.

[115] See http://www.nkom.no/aktuelt/nyheter/nkom-bereder-grunnen-for-å-unngå-nummermangel - Norwegian language only

7.5.2 Detailed Provisions – Numbering for M2M

Formal Definition of M2M

s3 of the 2004 Numbering Regulation provides the following legal definition of an M2M numbering resource in the Norwegian context:

> A non-geographical number from the national numbering plan which is to be used for automatic or partly automatic communication services for voice or data traffic where the number does not have an independent significance for the user.

A broader description of how Nkom defines M2M services as a whole is contained in s4.7 of *The Norwegian Electronic Communication Service Market: First half 2015*[116]:

> Machine-to-machine communication (M2M) means that devices are connected by means of different types of communications solutions, i.e. an automated exchange of data between machines. The communications solutions can be wireless or cable-based … M2M solutions are used in a range of industries and for a significant number of functions. This can include alarm systems and measuring systems, such as electricity meters. Within the transport sector, these solutions are used for alarm systems and to monitor and track vehicles and containers as well as electronic log-books. There are also many uses for these solutions in the health sector, such as the exchange of patient information. Automated payment solutions may also use these solutions.

Permitted Use of Numbering Resources for M2M

The use of both E.164 mobile numbers and E.212 Mobile Network Codes (MNCs) is permitted for M2M applications. For E.164 mobile numbers, M2M applications must use resources from one of the two numbering ranges reserved for that usage.

[116] See http://eng.nkom.no/market/telecom-services/statistics/the-norwegian-ecom-market-reports/_attachment/21447?_ts=151af634b25

Assignment of E.164 mobile numbers and/or E.212 MNCs to undertakings other than MNOs or MVNOs

E.164 mobile numbers are assigned to providers of mobile services, so not limited to MNOs and MVNOs.

MNCs are mainly assigned to MNOs and MVNOs (MNC has been assigned to e.g. GSM-R).

Availability of dedicated E.164 mobile number range for M2M services

There are two numbering ranges reserved for M2M services:

- 58x 12-digit range;
- 59x 8-digit range.

Both are non-geographic, i.e. used to serve both fixed-line and mobile applications. Ordinary mobile numbers cannot be used for M2M services, even where these services contain a limited voice telephony element.

Permitted use of national E.164 mobile numbers and/or E.212 MNCs to be used on a permanent extra-territorial basis for M2M services

s16 of the 2004 Numbering Regulations clearly states that allocated numbers may not be provided for permanent use outside of Norway without the permission of Nkom.

Permitted sharing by M2M service providers of E.212 MNCs

Nkom's response to the November 2016 CEPT WG NaN questionnaire indicated that sharing by M2M service providers of E.212 MNCs is not permitted.

Fees for the assignment and/or use of E.164 mobile numbers

The 2005 Fees Regulation[117] prescribes an annual fee of NOK10,000 for permission to use 8-digit and 12-digit numbers. An annual fee of NOK0.03 is charged for the fourth number in cases where graduated fees applied.

Differential treatment of applicable fees if mobile numbers are used for M2M services

The question is not applicable, since ordinary mobile numbers cannot be used for M2M services.

Fees for the assignment and/or use of E212 MNCs

The Fees Regulation prescribes an annual fee of NOK3000 for use of an E.212 MNC.

Differential treatment of applicable fees if MNCs are used for M2M services

There is no differential treatment for MNCs used for M2M services; the same fees apply regardless of the type of service.

Permitted use of overseas E.164 mobile numbers and/or E212 MNCs on a permanent extra-territorial basis for M2M services

In its response to the November 2016 CEPT WG NaN questionnaire, Nkom advised that there are no specific rules on the use of foreign numbering resources on a permanent extra-territorial basis in Norway. Nkom has subsequently confirmed that this means that such use is not currently permitted.

Do Number Portability requirements apply to resources used for M2M services?

In theory, the eight-digit 59 range of dedicated numbers for M2M usage are subject to the number portability requirements defined by Section 3-5 of the Regulations on Electronic Communications Networks and Services (Ecom Regulations). The 12-digit 58 M2M range is not covered by this

[117] Updated version in effect from 1st January 2016 – available on-line at https://lovdata.no/dokument/SF/forskrift/2005-02-21-168 (Norwegian language only)

requirement. No specific rules for M2M resources are defined. The wider issue of number portability is currently understood to be under regulatory consideration.

7.5.3 Detailed Provisions – Numbering for OTT

Formal Definition of OTT

InterConnect has not been able to locate a formal regulatory definition for OTT in Norway. As, however, Nkom has publicly stated its intention to work through the Body of European Regulators for Electronic Communications (BEREC) for the revision of sector legislation to promote equal treatment of traditional providers and global OTT providers[118], it would seem likely that any interpretation of OTT services adopted by the regulator will reflect wider European practice.

Permitted Use of Numbering Resources for OTT

The use of both E.164 mobile numbers and E.212 Mobile Network Codes (MNCs) is permitted for OTT applications. The assignment and use of E.164 numbers, however, is only permitted where the operator fulfils all obligations associated with the resource in question, e.g. registration with Nkom, number portability, unambiguous registration of end-users, access to land mobile networks and emergency services, and provision of location information. Not all OTT services will qualify for the assignment of E.164 mobile numbers in Norway, e.g. pure OTT services or services that only offer SMS. For services that do not fulfil the requirements set for the assignment and use of mobile numbers, Nkom can consider applications for assignment of geographic numbers or numbers in the 85x range reserved for IP telephony services in accordance with the requirements set for such assignments.

Types of E.164 numbers permitted for use with OTT services

Dependent on the nature of the service being offered, OTT applications may use numbers in the 2x, 3x, 5x, 6x or 7x eight-digit geographic ranges.
For IP-based voice telephony offerings considered to qualify as full mobile telephone services, numbers within the 85x eight-digit non-geographic range allocated for nomadic IP telephony services may be

[118] Source: http://eng.nkom.no/topical-issues/news/electronic-communication-services-networks-and-equipment

used also. Nkom will not assign to nor permit an operator to use mobile numbers for services that have no option of accessing land mobile networks.

Assignment of E.212 MNCs for OTT services to undertakings other than MNOs or MVNOs

In its response to the November 2016 CEPT WG NaN questionnaire, Nkom advised that E.212 MNCs for OTT services are not assigned to undertakings other than MNOs or MVNOs.

Fees for the assignment and/or use of E.164 mobile numbers

The 2005 Fees Regulation prescribes an annual fee of NOK10,000 for permission to use 8-digit numbers. An annual fee is charged for the fourth number in cases where graduated fees apply; this is set at NOK0.15 for numbers in the 2x, 3x, 5x, 6x and 7x ranges, and at NOK0.03 for numbers in the 85x range.

Differential treatment of applicable fees if mobile numbers are used for OTT services

There is no differential treatment for E.164 mobile numbers used for OTT services; the same fees apply regardless of the type of service.

Fees for the assignment and/or use of E.212 MNCs

The Fee Regulations prescribe an annual fee of NOK3,000 for use of an E.212 MNC.

Differential treatment of applicable fees if MNCs are used for OTT services

There is no differential treatment for MNCs used for OTT services; the same fees apply regardless of the type of service.

Do Number Portability requirements apply to resources used for OTT services?

Section 3-5 of the Regulations on Electronic Communications Networks and Services (Ecom Regulations) specify that service providers who use five- or eight-digit numbers pursuant to Section 16 of the Numbering Regulation must release that number to another provider should the end-user make a valid number portability request. No specific rules are defined for number resources used to support OTT

services. The wider issue of number portability is currently understood to be under regulatory consideration.

7.6 Singapore

7.6.1 Regulatory Background

Numbering resources in Singapore are administered by the Infocomm Media Development Authority (IMDA), the country's converged information, communications and media regulatory authority. Although the legislative underpinnings of the Singaporean regulatory regime are provided by the 1999 Telecommunications Act, most aspects related to numbering are addressed by various other instruments, chiefly the National Numbering Plan[119].

In 2010 the then regulator, the Info-Communications Development Authority of Singapore (IDA) evaluated the M2M data communication requirement and noted that M2M devices and machines needed to be uniquely identified over licensees' networks. It was felt that the demand for numbering or addressing resources for M2M communication would not be constrained by the size of Singapore's population and that the quantity of M2M devices and machines, if pervasively deployed, could reach millions within a few years. To address the issue, IDA developed a pilot M2M framework in 2010, taking the view that it would not be appropriate to open up existing telephone number levels for M2M services as these number levels were established primarily for person-to-person telecommunication, and that allowing M2M services to use these number levels might exhaust the numbering capacity much sooner than expected.

To ensure that there was sufficient numbering capacity for all M2M devices and machines in the future, and to differentiate M2M services from other services, IDA reserved a block of numbers for M2M services. The regulator also took the view that a maximum digit length should be adopted. Based on the International Telecommunication Union (ITU) E.164 numbering format, Singapore would allow numbers of up to 13-digit length, using the designated 4-digit Access Code (excluding the country code),

[119] October 2016 revision available on-line at https://www.imda.gov.sg/~/media/imda/files/regulation%20licensing%20and%20consultations/frameworks%20and%20policies/numbering/national%20numbering%20plan%20and%20allocation%20process/nnp_wd.pdf?la=en

based on current network routing technology and arrangements. During the pilot phase, a licensee wishing to provide M2M services would be allocated a unique 4-digit M2M Access Code, which they would be permitted to extend in order to generate and permutate the required M2M numbers to be assigned to M2M devices or machines. No further requirements were stipulated as this stage as IDA wished to monitor M2M technology and business trends and developments before finalising the framework under the terms of the National Numbering Plan[120].

In April 2013 the IDA issued a consultation paper on a proposed access code allocation framework for M2M services[121]. A Decision and Explanatory Memorandum contingent upon the responses to the consultation was published in July 2013[122], confirming service definitions, a dedicated 13-digit M2M numbering format, charging arrangements and implementation timescales. Although leaving the choice of whether or not to adopt M2M access codes up to individual licensees, the regulator took the opportunity to encourage adoption of the new M2M numbering system in view of the expected growth of M2M devices, and the resulting demand for numbers. While in accord with industry opinion that non-MSISDN identification addressing standards such as IPv6 addressing might determine the longer-term approach, the regulator's view was that there was no certainty at that point as to when such standards might become mainstream.

Aspects relating to the assignment and usage of numbering resources for VoIP services are addressed in the IMDA documents *Guidelines on Licensing and Regulatory Framework for IP Telephony Services in Singapore* and *Specific Terms and Conditions for IP Telephony Services* [123].

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[120] Source: s6-10 of April 2013 IDA consultation paper on proposed access code allocation framework for M2M services (q.v.)

[121] Available on-line at https://www.imda.gov.sg/~/media/imda/files/inner/pcdg/consultations/20130131_m2mframework/20130411_m2m_acallocationframework.pdf?la=en

[122] Available on-line at https://www.imda.gov.sg/regulations-licensing-and-consultations/consultations/consultation%20papers/2013/proposed-machine-to-machine-access-code-allocation-framework

[123] Available on-line via https://www.imda.gov.sg/regulations-licensing-and-consultations/licensing/licences/licence-for-the-provision-of-telecommunication-services/ip-telephony-framework

7.6.2 Detailed Provisions – Numbering for M2M

Formal Definition of M2M

s14 of the April 2013 consultation paper on a proposed access code allocation framework for M2M services proposed a formal definition for M2M as follows:

> M2M communication refers to the automated communication between machines and devices. In cases where M2M communication includes voice communication, these shall mean voice services within a pre-defined service feature and/or within an intended or a closed user group

This definition was subsequently adopted as suitable for current and future M2M service development.

Permitted Use of Numbering Resources for M2M

E.164 numbering ranges in Singapore are categorised into various services according to the first digit. The designation of numbers is such that the first digit of the number indicates the type of services offered by that number, i.e. numbers beginning with the digit '0' are reserved for international services and referred to as Level '0' short codes, numbers beginning with the digit '1' are reserved for special services and referred to as Level '1' short codes.

Licensed providers of M2M services are eligible to use E.164 numbers. Holders of Facilities-Based Operator (FBO) licenses may choose between the dedicated range reserved for M2M services or any other numbering range with whose terms of use their services are compliant, namely the eight-digit Level '6' range used for PSTN and IP telephony applications and eight-digit Level '8' and Level '9' Radio Network codes.

Holders of Individual Service-Based Operator (SBO) licenses wishing to deliver M2M services are only eligible for the grant of numbers in the dedicated M2M range in Level '1.

There is no restriction on the use of E2.12 MNCs for M2M services, though licensees are required to seek the approval of the regulator for any additional services which they intend to provision using these resources.

Assignment of E.164 mobile numbers and/or E.212 MNCs to undertakings other than MNOs or MVNOs

Generally, only FBO licensees are eligible for Level '1' short codes. However, Service-based Operator (SBO) (Individual) licensees who propose to deliver M2M services are eligible to apply for numbers in the dedicated M2M range in Level '1'. SBO licensees are usually service providers intending to lease telecommunication network elements (such as transmission capacity and switching services) from an FBO licensee so as to provide their own telecommunication services, or to resell the telecommunication services of FBOs to third parties, but may also include entities who have deployed telecommunication network, systems and facilities within their own property boundaries and who wish to offer telecommunication services to third parties resident within those boundaries.

Level '6' PSTN codes are generally granted only to FBO licensees[124]. Level '8' Radio Network codes are granted to FBO and SBO (Individual) licence holders licensed as Mobile Virtual Network Operators (MVNO) offering Radio Network services[125].

Neither are E2.12 MNCs allocated to parties other than suitably-qualified FBO or SBO licensees.

Availability of dedicated E.164 mobile number range for M2M services

IDA has defined a 5-digit Access Code (144xx) within the Level '1' special services range for the exclusive use of M2M services and allows qualifying licensees to self-manage the rest of the following digits to form the M2M number. Licensees are encouraged to utilise the full 13-digit range (including the M2M Access Code) to maximise the addressing capacity. Thus, for a given allocation of 144xx, the receiving operator could create a range of M2M numbers from 144xx 0000 0000 to 144xx 9999 9999) for M2M addressing purposes. With 13 digits, each 5-digit number level will allow a total of 100 million numbers.

[124] See s5.3 NNP

[125] See s6.4 NNP

Permitted use of national E.164 mobile numbers and/or E.212 MNCs to be used on a permanent extra-territorial basis for M2M services

s3.7.1 of the NNP facilitates the use of Singaporean number resources in connection with international roaming services. No clear distinction is made between temporary and permanent use in this regard. IMDA advises that requests for permanent extraterritorial use may be assessed on a case-by-case basis.

Permitted sharing by M2M service providers of E.212 MNCs

IMDA advises that MVNOs can use the MNCs of MNOs for the provision of M2M services.

Fees for the assignment and/or use of E.164 mobile numbers

Eligible licensees may be allocated Level '8' or Level '9' mobile numbers through either administrative allocation or an auction process[126]. Operators may make a request for such numbers through administrative allocation when their number utilisation of their existing allocated numbers is more than or equals to 80%. For these requests, number levels (i.e. in blocks of 10,000) will generally be allocated in a sequential manner. An auction process may be used either where IMDA initiates availability of a particular range, or where the licensee requests out-of-sequence numbers not covered by Administrative Allocation or the sequential number level bidding scheme. In the case of an auction initiated by IMDA, a minimum bid price of SGD25,000 per number level will apply[127]. In the case of out-of-sequence numbers requested by the licensee, the minimum bid price will be set at SGD500,000 for a choice number level of the format 'AAAA XXXX' (e.g. '6666 XXXX') and SGD150,000 for all other choice number levels[128].

Level '1' numbers within the dedicated 144xx M2M range have their own provisions, summarised in the following section.

[126] See 4.5 of NNP

[127] See Annex 7 s3 of National Numbering Plan (NNP)

[128] See Annex 8 s4 of National Numbering Plan (NNP)

Differential treatment of applicable fees if mobile numbers are used for M2M services

s3.8.3 of the NNP prescribes that FBO licensees may apply for up to three M2M access codes without charge. For each subsequent M2M access code allocated after the third access code, a fee of SGD10,000 per M2M access code will be levied.
SBO (Individual) licensees may apply for up to two M2M access codes without charge. For each subsequent M2M access code allocated after the second access code, a fee of SGD10,000 per M2M access code will be levied.

Licensees failing to put allocated M2M access codes into operation within 12 months from the date of assignment by IMDA shall be required to pay a Recovery Fee of SGD20,000 before they can apply for further M2M access codes. IMDA may, if justified, grant a one-time extension to the implementation date for a period of up to 6 months.

Fees for the assignment and/or use of E212 MNCs

IMDA advises that there are no fees charged for the assignment/use of E.212 MNCs.

Differential treatment of applicable fees if MNCs are used for M2M services

There are no fees for the assignment/use of E.212 MNCs.

Permitted use of overseas E.164 mobile numbers and/or E212 MNCs on a permanent extra-territorial basis for M2M services

IMDA advises that requests for permanent extraterritorial use may be assessed on a case-by-case basis.

Do Number Portability requirements apply to resources used for M2M services?

Number portability requirements apply to the use of number levels '6', '8' and '9'. There is no number portability requirement for the use of the dedicated 144XX M2M access code.

7.6.3 Detailed Provisions – Numbering for OTT

Formal Definition of OTT

IMDA advises that there is presently no overarching regulatory definition for OTT services in Singapore, OTT service being commonly viewed as services provisioned over the Internet.

However, the IMDA's *Guidelines on Licensing and Regulatory Framework for IP Telephony Services in Singapore*[129] do provide the following definition for IP Telephony (VoIP) services:

> Any voice over Internet Protocol services offered using an E.164 telephone number ("IP telephony number") allocated to customers in Singapore, which allow customers to make and receive voice, data and/or video calls using the same IP telephone number from any domestic or overseas location where broadband Internet access is available.

For Internet-based television services, the following definition is set out within s1.5 of the Singapore Code of Practice for Television Broadcast Standards (Chapter 28 of the Broadcasting Act)[130]:

> "Over-the-top TV service" or "OTT TV service" means a licensable TV broadcasting service delivered over the open Internet.

Permitted Use of Numbering Resources for OTT

There is no explicit prescription on the use of numbering resources for OTT services. Numbers are assigned based on the services defined in the Singaporean National Numbering Plan.

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[129] See https://www.imda.gov.sg/~/media/imda/files/regulation%20licensing%20and%20consultations/licensing/licenses/iptellg.pdf?la=en

[130] See https://www.imda.gov.sg/~/media/imda/files/regulation%20licensing%20and%20consultations/consultations/completed%20consultations/consultation%20papers/5/proposed%20code%20of%20practice%20for%20television%20broadcasting%20standards.pdf?la=en

Types of E.164 numbers permitted for use OTT services

As a rule, there is no discrimination in the use of numbering resources for OTT and other services, and providers of licensed providers of OTT services are eligible for number allocations in the normal way provided that they meet the appropriate regulatory requirements.

Two number ranges are specifically identified for use in connection with IPT services:

- Eight-digit numbers beginning with the digit '3' (Level '3') are reserved for use for IP Telephony (IPT) services;
- Eight-digit numbers beginning with the digit '6' (Level '6') are reserved for use for PSTN service and IP Telephony (IPT) service.

FBO licensees offering IPT service meeting the licensing obligations imposed by IMDA are eligible for eight-digit numbering blocks within both level '6' and level '3'. SBO (Individual) licencees are only eligible for the direct assignment of level '3' numbers, but may enter into a commercial agreement with an FBO licensee to obtain services with number level "6" and use such service as an input to provide their own IP telephony service[131].

The first four digits of the 8-digit IPT numbers uniquely define a set of numbers referred to as a number level. One number level thus consists of 10,000 numbers.

s9 of the IMDA document *Specific Terms and Conditions for IP Telephony Services*[132] *sets* additional conditions for the provision of IP telephony services utilising Level '6' telephone numbers. Licensees are required to ensure that subscribers to such services must be able to receive and make voice calls from/to subscribers on any public switched telecommunication network, public mobile network or public digital voice network in Singapore, be able to access national emergency and directory enquiry services, comply with the same quality of service standards as may be established by the regulator for fixed network telecommunication services, and are only provided to domestic customers (within Singapore) with Singapore registered and billing addresses.

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131 See s2 IMDA *Guidelines on Licensing and Regulatory Framework for IP Telephony Services In Singapore*

132 See https://www.imda.gov.sg/~/media/imda/files/regulation%20licensing%20and%20consultations/licensing/licenses/ipteltcs.pdf?la=en

Assignment of E.212 MNCs for OTT services to undertakings other than MNOs or MVNOs

E2.12 MNCs are only allocated to suitably-qualified FBO or SBO licensees.

Fees for the assignment and/or use of E.164 mobile numbers

Eligible licensees may be allocated Level '8' or Level '9' numbers through either administrative allocation or an auction process[133]. Operators may make a request for such numbers through administrative allocation when their number utilisation of their existing allocated numbers is more than or equals to 80%. For these requests, number levels (i.e. in blocks of 10,000) will generally be allocated in a sequential manner. An auction process may be used either where IMDA initiates availability of a particular range, or where the licensee requests out-of-sequence numbers not covered by Administrative Allocation or the sequential number level bidding scheme. In the case of an auction initiated by IMDA, a minimum bid price of SGD25,000 per number level will apply[134]. In the case of out-of-sequence numbers requested by the licensee, the minimum bid price will be set at SGD500,000 for a choice number level of the format 'AAAA XXXX' (e.g. '6666 XXXX') and SGD150,000 for all other choice number levels[135].

Numbers with certain identifiable pattern in the last four digits are identified as 'Golden Numbers'[136]. IMDA charges licensees a one-time sum of SGD50 per 'Golden Number' for PSTN, cellular and IPT services. With 486 Golden Numbers in a number level (i.e. 10,000 numbers), each cellular or IPT number level is charged at SGD24,300.

Differential treatment of applicable fees if mobile numbers are used for OTT services

There is no differential treatment of number resources used for OTT and other purposes.

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[133] See 4.5 of NNP

[134] See Annex 7 s3 of NNP

[135] See Annex 8 s4 of NNP

[136] See Table 12.1 of NNP

Fees for the assignment and/or use of E.212 MNCs

IMDA advises that there are no fees charged for the assignment/use of E.212 MNCs.

Differential treatment of applicable fees if MNCs are used for OTT services

Fees are not charged for the assignment/use of E.212 MNCs.

Do Number Portability requirements apply to resources used for OTT services?

In general, number portability requirements apply to the use of numbering resources in Levels '6', '8' and '9'. There is no overarching differentiation between the use of resources for OTT and other services.

A limited exemption does apply to some IP telephony services. s3.1 of the IMDA's *Guidelines on Licensing and Regulatory Framework for IP Telephony Services in Singapore* states that FBO or SBO licensees offering IPT services with either 8-digit Level '3' numbers or other E.164 telephone numbers issued by overseas administrators will not be required to provide number portability, unless otherwise informed by IMDA. FBO and SBO licensees providing IPT service with Level '6' numbers are required to provide number portability at similar standards to that established for basic telephony services associated with Level '6' numbers.

8. Annex C: Characterisation of Demand for M2M and OTT

8.1 M2M

Despite the degree of current interest in the M2M/IoT sector and resultant volume of commentary and analysis, deriving realistic predictions of future demand poses certain challenges. Raw data is spread over many disparate sources, while many detailed market predictions/statistics are in the form of private analyst reports rather than public-domain information. In addition, from what information has been published it is clear that there exists considerable latitude between estimates and projections from different sources. This is hardly surprising, given that the M2M sector is in the development state and resulting uncertainty over the exact nature of market impact.

In addition, predicting likely demand for M2M-related mobile numbering resources cannot be satisfied by a straightforward translation of connection/subscriber numbers. There are several reasons for this. Firstly, not all M2M connections will be served by mobile technologies, alternatives including fixed-line connections, powerline (PLC) technologies using electricity supply lines as data channels, and a variety of short- and long-range radio access technologies. Some applications link multiple end devices to a hub using wireless mesh technologies such as Zigbee or in-building WiFi, with a single consolidated connection (cellular or otherwise) providing backhaul. In both cases, the proportion of M2M connections served by mobile technologies is likely to vary substantially across market sectors and technologies, across geographies, and over time. Last but not least, in an internationalised environment with the sale and use of products and services transcending national borders, and the international use of number resources through both roaming and permanent extraterritorial use, the geographic placement of an M2M device will not necessarily correspond with the origin of the number resources used to service it.

8.1.1 Predicted Demand for Services

In assessing the likely number of cellular M2M connections, InterConnect has referred to a number of independent analyst studies and predictions, namely:

- Berg Insight's report *The Global M2M/IoT Communications Market* (published December 2016)[137];

[137] Kindly shared with InterConnect by ComReg

- Ericsson's *Mobility Report November 2016*[138];
- Cisco's *Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2016–2021*[139].

In each case, analyses of likely numbers of connections have been abstracted at global and European levels. Reference has also been made to Machina Research's August 2016[140] annual guidance on the size of the IoT market opportunity; unfortunately, the figures released by Machina into the public domain address the market at a global scale only, but are still worth considering due to Machina's knowledge of this area.

At a global level, Berg Insight, Ericsson and Machina all appear to concur as to a 2016 baseline of around 400 million M2M cellular connections, albeit with slight variances in predicted growth leading to between 1.2 and 1.5 billion such connections by 2022, at compound annual growth rates (CAGRs) of between 21 and 25%. In contrast, Cisco's analysis implies a higher 2016 baseline of some 780 million M2M cellular connections, rising to a predicted 4.4 billion by 2022, representing a CAGR of 34%. The predictions of each (including some interpolations of data on the part of InterConnect) are summarised in the following Tables[141]:

Predicted M2M cellular connections - global								
Thousands	2016	2017	2018	2019	2020	2021	2022	CAGR 2016-2022
Berg Insight	398,138	520,206	674,142	848,796	1,046,907	1,274,770	1,537,254	25.25%
Ericsson	400,000	498,577	621,447	774,597	965,489	1,203,426	1,500,000	24.64%
Cisco	780,000	1,042,274	1,392,736	1,861,041	2,486,813	3,323,000	4,440,353	33.62%
Machina	403,287	486,947	587,962	709,932	857,205	1,035,028	1,249,740	20.74%

Table 9 Predicted M2M Cellular Connections - Global

[138] See https://www.ericsson.com/assets/local/mobility-report/documents/2016/ericsson-mobility-report-november-2016.pdf (global) and https://www.ericsson.com/assets/local/mobility-report/documents/2016/ericsson-mobility-report-november-2016-rwe.pdf (Western Europe)

[139] See http://www.cisco.com/c/dam/assets/sol/sp/vni/forecast_highlights_mobile/index.html

[140] See https://machinaresearch.com/news/press-release-global-internet-of-things-market-to-grow-to-27-billion-devices-generating-usd3-trillion-revenue-in-2025/

[141] It is worth noting that most of these predictions fall within the limits of other predictions of service demand to which InterConnect has been granted limited access but which, for reasons of confidentiality, cannot be reproduced in this report

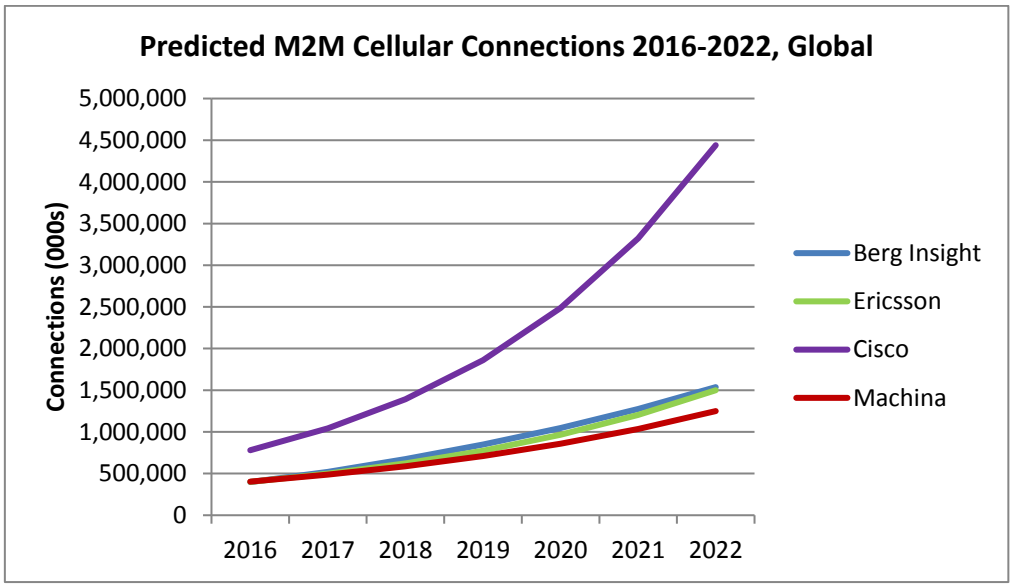

Figure 2 Predicted M2M Cellular Connections 2016-2022 - Global

At a European level, both Berg Insight and Ericsson suggest 2016 baselines of just over 100 million M2M cellular connections, though in this case their growth predictions vary, Berg Insight suggesting a 2016-2022 CAGR of 23% to take their predicted 2022 figure to 421 million connections, while Ericsson proposes a more optimistic growth rate of 39% CAGR, resulting in a predicted 2022 total of nearly 774 million connections. As before, Cisco suggests a higher 2016 baseline, this time of 202 million connections, and a higher growth rate than that predicted by Berg Insight though not, interestingly enough, as high as that suggested by Ericsson. As a result, Cisco's 2022 prediction stands at some 1.115 billion cellular M2M connections. Again, the predictions of each analyst (including some interpolations of data on the part of InterConnect) are summarised in the following figures:

Predicted M2M cellular connections - Europe								
Thousands	2016	2017	2018	2019	2020	2021	2022	CAGR 2016-2022
Berg Insight	118,086	150,863	195,977	243,491	296,040	354,920	421,657	23.63%
Ericsson	106,000	144,231	195,797	290,950	373,251	551,653	773,900	39.28%
Cisco	202,344	268,945	357,467	475,126	631,513	839,375	1,115,655	32.91%

Figure 3 Predicted M2M Cellular Connections - Europe

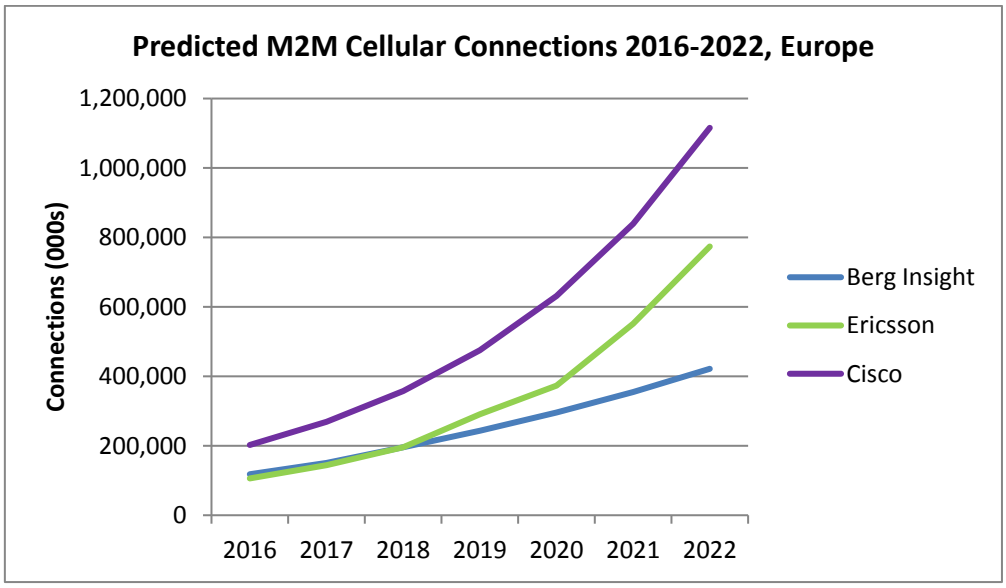

Figure 4 Predicted M2M Cellular Connections 2016-2022 - Europe

8.1.2 Drivers/Determinants Affecting Likely Demand for Mobile Number Resources for M2M Activities

There is a wide range of different factors which InterConnect regards as likely to affect the likely nature and scale of demand for mobile number resources serving M2M activities. Some of the most significant are briefly outlined below:

- The M2M/IoT market as a whole is still effectively at an immature (and highly volatile) growth stage. There is still a lack of real consensus as to overall size and growth rates (though different analyst predictions on these are progressively converging), much more so on geographical and market/product segmentation. For many territories and markets, there is no real visibility as to how large or how quickly the uptake of M2M applications may grow;
- There is a similar lack of clarity as to what applications will use what connective technologies and in what proportions. For some markets, such as automotive, operational requirements effectively presuppose the use of cellular connections. Conversely, in many countries adoption of smart metering for electricity supply has been implemented via powerline (PLC) technology using the electricity supply lines to feed data back to centralised aggregators for bulk transmission to data centres. For some others, however, such as smart buildings, telemetry, usage-based services and wearables, there is considerable latitude for connections to be made over a variety of communications platforms, by smartphone-based apps in place of dedicated sensors, or by linking multiple connections via a radio-based mesh to a central hub served by a single cellular or landline connection;

- The sheer size of some of these markets means that relatively small changes in market growth can have a disproportionate effect upon the absolute number of resulting connections. Even where reasoned predictions as to the likely number of M2M sensors/connections exist, it is not easy to translate this into demand for mobile numbers without far greater knowledge of adoption rates and industry dynamics, many of which have yet to evolve;
- M2M adoption rates are obviously variant across technologies and geographies. Where it happens that service providers using numbering resources from any one particular national allocation concentrate their provision on particular markets, regional and sector differentials in uptake could cause the resulting growth in demand for numbers to vary significantly from regional or global averages;
- In any quickly-evolving market, products may have a relatively short life due to being usurped by competitive products or falling out of fashion with end users. This may have an impact on demand for numbering resource, especially if OEM applications are relatively quickly replaced by aftermarket solutions with their own allocated numbers;
- The development of permanent extraterritorial use of number resources is by no means complete and, while the position of the EU presently seems to suggest a more general acceptance of such usage, it is as yet unclear how regulatory positions relating to this will be resolved in many other countries. As a result, it is difficult to predict with any degree of certainty what levels of demand may exist for extraterritorial numbers, nor what level of resource may be made available. Equally, dependent on different levels/values of geographic demand for particular products and services and the prevailing regulatory approach to the extraterritorial use of foreign number resources in each of those markets, the relative attractiveness of number resources from any particular source could vary dramatically across industry sectors;
- Other than for established examples (which may not in themselves prove a reliable guide to future practice), there is relatively little in the way of evidence to suggest which M2M managed service providers, OEMs (or even providers of major sub-systems to OEMs) may choose to use mobile numbers from any particular national resource, for what verticals/clients, services, or in what proportions relative to resources from other sources such as the ITU and other national resources. The list of potential influencing/deciding factors governing any such decision is a long one, covering issues such as overall number availability, number format, block sizes, costs, terms of use, applicability to overseas markets, ease of allocation, legal/physical domicile of OEM/service provider (or even both), existing industry connections and relationships, and likely geographical distribution of end users. Manufacturers and sellers of more specialised (i.e. slow-

selling) M2M products may well choose to provision connectivity by means of an off-the-shelf solution from one of the established managed services providers, who may then choose to provision demand using numbers allocated to them from other countries.

It is difficult if not impossible to quantify the exact effect of these factors at present, simply due to the sheer number of unknowns and variables present within the M2M ecosystem as a whole.

8.1.3 Predicted Demand for Numbers from Irish Resources

As noted above, due to the evolving nature of the M2M market, there is considerable uncertainty not just with regard to overall levels of activity but also the extent to which these will need to be supported by mobile numbering resources. In addition, given the global nature of much of the activity, there can be little in the way of a strong automatic correlation between the geographic location of activity and the national/international origins of supporting number resource allocations.
For this reason, in modelling likely demands upon Irish national resources for M2M mobile numbers, InterConnect has adopted a three-level approach:

1. Analysis of historic M2M mobile subscriptions[142] data in Ireland (as published by ComReg in its Quarterly Key Data Reports) and trending this forward over time using a variety of growth scenarios. This approach should deliver an effective 'lower limit' prediction of demand for Irish mobile numbers;
2. Considering requests that ComReg has received from M2M Service Providers for new blocks of mobile numbers to meet their requirements to develop M2M products and services;
3. Developing predictions for a potential 'upper limit' of demand for Irish numbering resources, based on assessed levels of M2M market activity at pan-European and global levels, the likely accessibility to such activities by overseas numbers used on a permanent extraterritorial basis, and the assumed degree to which Irish numbering resources might fill the resulting demand.

1 - Trend analysis of Irish M2M mobile subscriptions data

ComReg publishes data on M2M mobile subscriptions on a quarterly basis in its Quarterly Key Data Report. Table 10 below summarises the most recent data.

[142] M2M subscriptions to each of the Irish mobile service providers.

	2015 (Q4)	2016 (Q4)	2017 (Q2)
M2M mobile subscriptions	554,040	670,389	746,803
Growth rate (%)	19% (est.)	21%	23% (annualised)

Table 10 – Cumulative M2M mobile subscriptions in Ireland 2015 - 2017

M2M mobile subscriptions have been growing by an annual average of 21% since 2015. ICC have extrapolated the current M2M mobile subscriptions data forward on the basis of three different growth scenarios:

1. A 'Bottom-Line' growth rate of 21% corresponding with a continuation of M2M mobile subscription demand patterns observed since 2015 (which also corresponds with Machina's August 2016 estimate of global M2M/IoT market growth);
2. A 'Mid-Line' growth index of 25% per annum (based on Ericsson's November 2016 estimate of global M2M/IoT market growth) applied to the most recent M2M mobile subscriptions data;
3. A 'Top-Line' growth index of 34% per annum (based on Cisco's February 2017 estimate of global M2M/IoT market growth) applied to the most recent M2M mobile subscriptions data

Thousands	2016	2017	2018	2019	2020	2021	2022
Bottom-Line Growth (21%)	670	811	981	1187	1436	1738	2103
Mid-Line Growth (25%)	670	838	1047	1309	1636	2045	2556
Top-Line Growth (34%)	670	898	1203	1612	2160	2895	3879

Table 11 – Predicted cumulative demand (2017 – 2022) for Irish M2M mobile numbers based on current M2M mobile subscriptions

Assuming that each M2M mobile subscription requires one mobile number, the above table forecasts a demand of between 2.1m and 3.9m numbers for M2M use in 2022. While this level of demand would not exhaust the current mobile numbering ranges within the forecast period, the top-line forecast would certainly hasten that date. This level of demand taken must be viewed alongside the demand for Irish mobile numbers for P2P communications, both of which would place pressure on the mobile number ranges that are currently open.

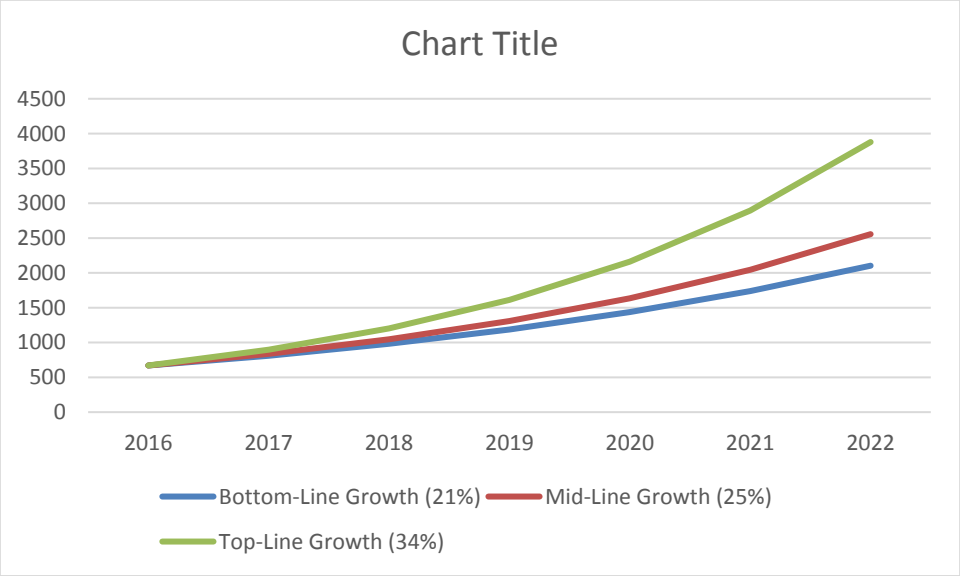

Figure 5 – Predicted cumulative demand (2017 – 2022) for Irish M2M mobile numbers based on current M2M mobile subscriptions

InterConnect interviewed a number of Irish mobile service providers currently allocated Irish mobile number resources for M2M activities. In general, their view was that demand for numbers for M2M services would continue as per recent trends. However, it was also felt that demand for such numbers could potentially be met from existing free number blocks or stocks of numbers allocated to service providers, or potentially from international numbering resources. Therefore, it was felt the M2M services may not place an undue strain on current mobile numbering ranges.

2 – Demand from M2M service providers not currently allocated Irish mobile numbering resources

Interconnect also interviewed Irish and International M2M service providers currently not allocated (but have requested) Irish national number resources. Their responses to these interviews provided data as to their current and expected requirements for Irish mobile numbers to support their business plans at both the National and International level. In the interests of confidentiality, the responses of the individual interviewees have been consolidated to provide a year-by-year assessment of demand for Irish mobile numbers, interpolating values where necessary. Table 12 shows that there is potential demand from Irish and International M2M service providers for 38.4m Irish mobile numbers by 2022.

Thousands	**2018**	**2019**	**2020**	**2021**	**2022**
Total	1,566	5,598	16,024	27,398	38,400

Table 12 – Predicted cumulative demand (2018 – 2022) for Irish M2M mobile numbers from Irish and International M2M service providers

The sharp increase in predicted annual demand for Irish mobile numbers for M2M services over and above the 2015-2017 trends recorded by ComReg in its *Quarterly Key Data Reports* may be attributed to the intended deployment by the service providers of such numbers in extraterritorial use outside Ireland. One particular driver of demand in this regard is the automotive market, the extraterritorial use of Irish national numbers overseas being regarded as desirable in terms of aspects such as reducing the complexity of carrier relations and the type of services being offered. This level of demand would exhaust existing mobile ranges before 2020.

For certain sectoral markets, it has been suggested that the modelling of likely demand for number-dependent services will be easier to undertake than for others. One suggested example has been that for motor vehicles, given the legislative requirement across the European Union for all new cars and commercial vehicles to be equipped with the emergency calling E-Call facility from April 2018. In this regard, it is noted that at least one European regulator[143] has undertaken its own modelling of likely numbering requirements as they pertain to the national market for E-call-equipped road vehicles, and InterConnect has performed a similar exercise with regard to Ireland.

Vehicle registration data provided by the Central Statistics Office of Ireland (CSO) and Society of the Irish Motor Industry (SIMI) indicates that around 1.99 million private cars and 330,000 goods vehicles were registered for use in Ireland at the end of 2015[144]. New vehicle registrations are understood to have amounted to some 143,000 private cars and 43,000 goods vehicles in 2016, though the overall total of registered vehicles will obviously be affected by other factors also, notably imports into Ireland of pre-used vehicles from other territories and, conversely, any reduction in numbers brought about by existing Irish-registered vehicles being exported or scrapped. SIMI's Q2 2016 analysis reckoned that current new vehicle sales were at around a 'natural level', but that future sales prospects had to balance positive economic indicators against a range of negative factors including the availability of imported used cars, financial pressures on the personal sector and continuing uncertainty as to the overall

[143] BIPT of Belgium in its January 2017 consultation regarding the numbering aspects of eCall services – see s7.1.1 of this report for further details

[144] See CSO Vehicle Population Report at http://www.cso.ie/multiquicktables/quickTables.aspx?id=tha10_1 and SIMI/DoneDeal Motor Industry Review reports at http://www.simi.ie/Statistics/Quarterly+Report.html

economic impact of Brexit. For this reason, and given the rather volatile nature of previous vehicle sales levels in Ireland, InterConnect chose to apply a conservative estimate to the likely growth of new vehicle sales, assuming year-on-year growth of 4% up to 2019, with a gradual decline thereafter to 3.5% growth in 2022. On this basis, forecast sales of new private cars in 2022 would amount to some 179,000 units, slightly lower than the previous reported peak value of 181,000 in 2007.

Third-party analysis published by Statista.com[145] suggests that overall connected car penetration in Ireland stood at some 3.8% in early 2017. As no specific predictions were made for commercial vehicles, InterConnect has assumed a slightly lower baseline penetration of 3% for these, reflecting the lesser likelihood of entertainment-related connected technologies having been specified by buyers of such vehicles to date (Heavy Goods Vehicles – HGVs – may exhibit relatively higher degrees of connectivity reflecting specialised business-related applications such as vehicle tracking, but their overall numbers are small, at round one-tenth of overall commercial vehicle annual sales and perhaps 2-3% of private car sales). With some manufacturers (e.g. Opel) already providing connected car functionality as standard on certain models, and this trend likely to spread to reflect both increasing customer demand and the desire of vendors to ensure that vehicles are ready for the introduction of mandatory E-Call functionality in 2018, InterConnect has assumed that some 50% of new vehicle registrations in 2017 (private car and commercial vehicle) will feature connected technologies. For 2018, the presumed proportion of new vehicles sold and enabled for connectivity is raised to 75% to reflect the requirement for an E-Call facility from April of that year, with 100% connectivity of new vehicles sold thereafter.

On this basis, InterConnect has arrived at the following predictions of numbers of connected road vehicles in Ireland between 2017 and 2022[146]:

Predicted Number of Connected Vehicles in 000s				
	New Private Car Registrations by Year	New Commercial Vehicle Registrations by Year	Total New Registrations by Year	Cumulative Total of Connected Vehicles

[145] Summary of Connected Car Outlook Report for Ireland at https://www.statista.com/outlook/320/140/connected-car/ireland#

[146] InterConnect's overall prediction for M2M-related numbers include E-Call and other connected car requirements. Due to extraterritorial usage, however, there will not necessarily be a direct correlation between the number of connected road vehicles registered in Ireland and quantities of Irish mobile numbers allocated for connected vehicle use.

2016	*Baseline population estimated at 3.8% of all private cars and 3.0% of all commercial vehicles*				*87*
2017	*Existing population plus 50% of new registrations*	74	21	95	183
2018	*Existing population plus 75% of new registrations*	116	33	149	332
2019	*Existing population plus 100% of new registrations*	161	45	206	538
2020		167	47	214	752
2021		173	49	222	974
2022		179	51	230	1,204
Figures rounded to nearest 1,000 as appropriate					

Table 13 Predicted Numbers of Connected Road Vehicles in Ireland, 2017-2022

On the basis of available statistics, and extrapolating existing (2014-15) trends of 2.2% year-on-year growth, InterConnect estimates the total size of the Irish vehicle *parc* at around 2.7 million vehicles by 2022. The fact that this is more than double the predicted number of connected vehicles at that time reflects the continuing operation of significant quantities of older, non-connected vehicles. Whilst replacement rates are open to speculation, not least with regard to the impact of imports of used vehicles from abroad, other modelling exercises in this respect have suggested a typical vehicle life of perhaps 15 years, on which basis by 2032 the first generation of E-Call-equipped vehicles would themselves be replaced. Logically, the total size of the Irish vehicle *parc* at this latter point[147] will represent a likely upper limit for E-Call-equipped vehicles once the vast majority of older, non-equipped vehicles have been replaced at the end of their natural lifespan.

InterConnect's analysis is represented graphically in

[147] An informal growth extrapolation to 2032 at a constant 2.2% growth per annum implies an overall vehicle *parc* of just under 3.4 million by that date. However, given the number of variables with potential ability to affect this outcome – not least the apparent volatility of new vehicle sales in Ireland – InterConnect would not recommend the unconditional extension of its methodology to 2032 without the support of extensive additional market analysis and modelling work to justify any such predictions. Such is clearly outside the scope of this study.

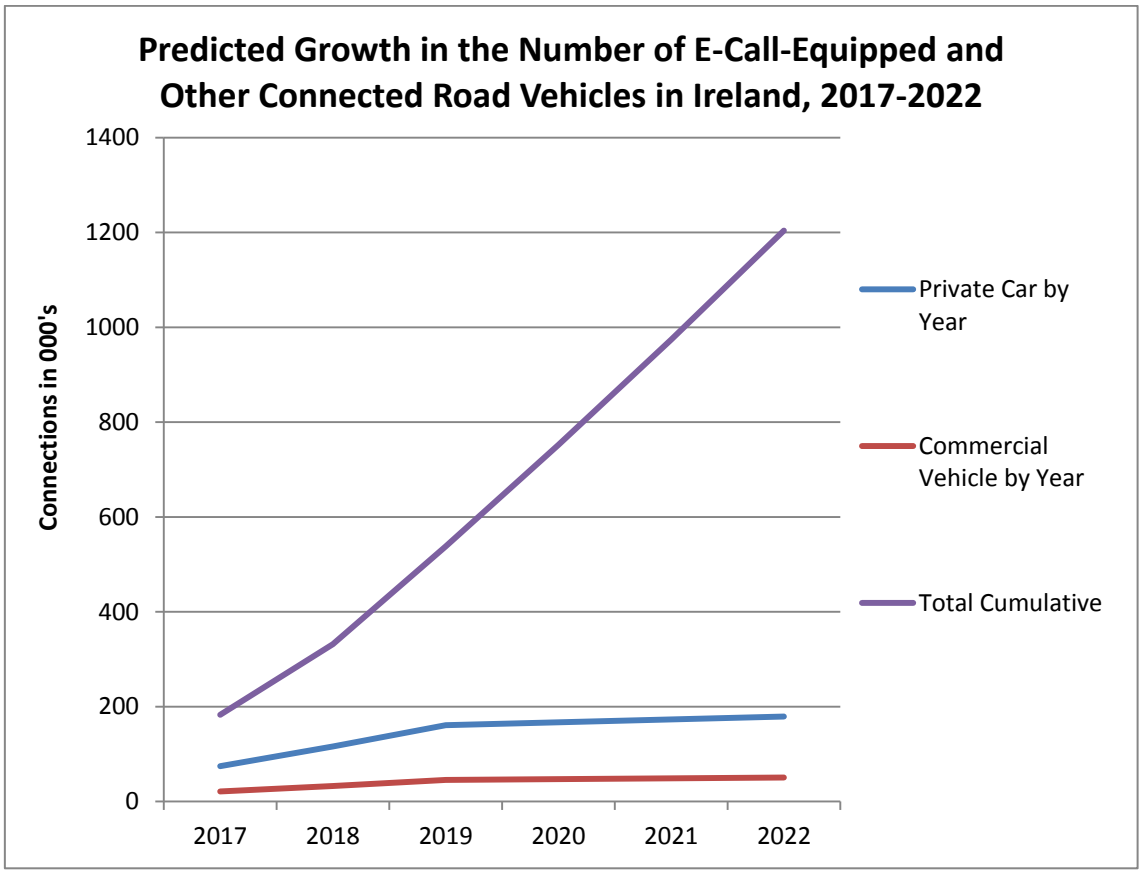
Predicted Growth in the Number of E-Call-Equipped and Other Connected Road Vehicles in Ireland, 2017-2022
Connections in 000's
1400
1200
1000
800
600
400
200
0
2017
2018
2019
2020
2021
2022
Private Car by Year
Commercial Vehicle by Year
Total Cumulative

Figure 6.

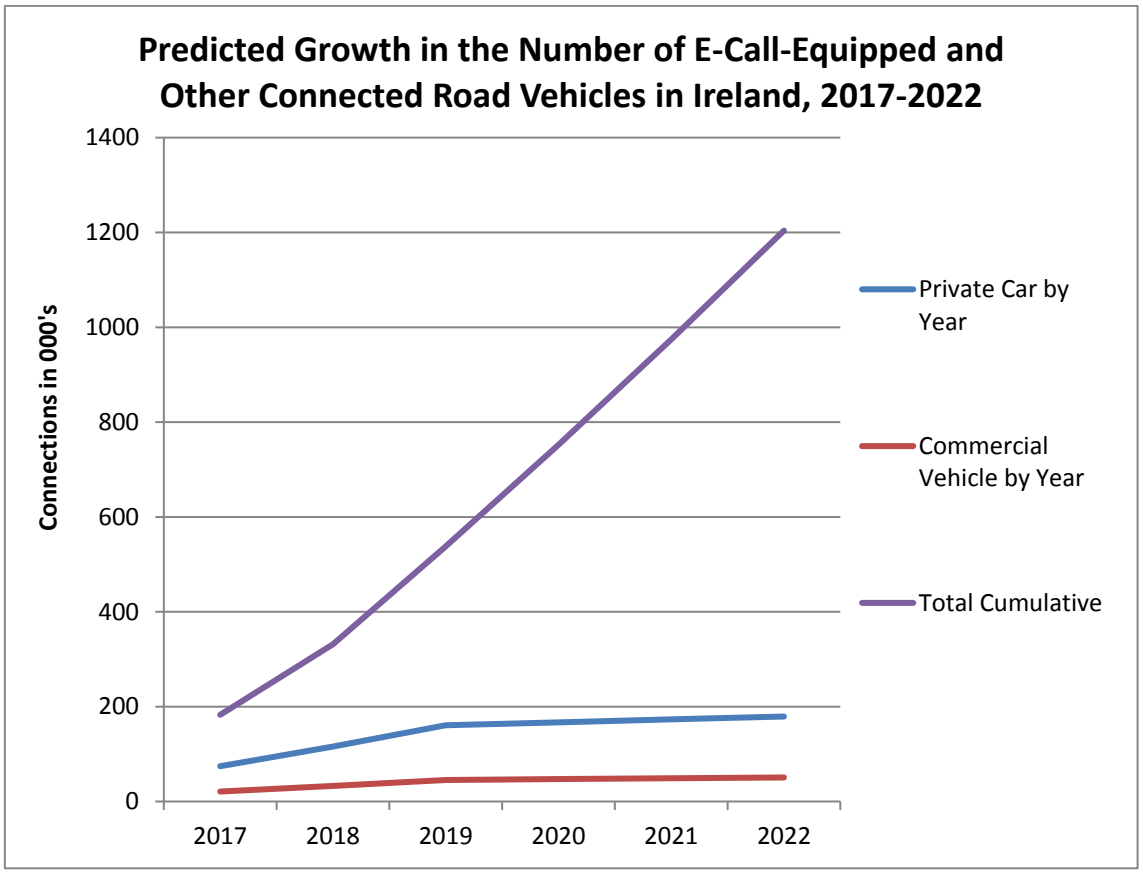

Figure 6 Predicted Growth in the Number of E-Call-Equipped and Other Connected Road Vehicles in Ireland, 2017-2022

Translating this to a prediction of actual mobile number requirements, however, is a considerably less straightforward process, with a number of hard-to-quantify factors affecting any such prediction. These include:

- There is a clear requirement for not less than one mobile number per vehicle to support E-Call. What is less certain is:
    - How many vehicle manufacturers or their local representatives may specify multiple M2M numbers to support a suite of services (as opposed to supporting multiple in-car services through one single integrated number);
    - To what extent the specification of multiple numbers per vehicle may extend across any given manufacturer's product range (i.e. might relatively cheap entry-level cars and vans tend towards only one number, whereas more expensive products with greater levels or more specialised types of connectivity justify more than one OEM-provided M2M number?);

- Will Irish-market vehicles be provisioned with Irish mobile numbers by the original supplier e.g. via Over-the-Air (OTA) methods, or with extraterritorial numbers obtained from overseas jurisdictions by the manufacturer or their selected systems/service provider?
- Correspondingly, how many Irish numbers may be sought by manufacturers or their selected systems/service providers for vehicles neither manufactured, sold nor customarily used in Ireland?
- For E-Call services, it seems likely that the M2M capability will remain with the service provider selected by the manufacturer or their in-country representatives at the time of initial sale. For other connected car applications, however, there is little visibility as to whether end-users will continue with the original manufacturer's service suite past the end of the initial agreement (probably the vehicle's warranty period), switch to a different service provider (or even more than one provider) necessitating the allocation of additional number(s), or simply allow non-essential services to lapse altogether.

Lastly, it is worth noting that mobile numbers allocated in conjunction with connected vehicle usage may fall out of use for several reasons, including the decision of the owner not to renew subscription-based or other non-statutory services (or perhaps to obtain substitute services from an alternative provider using a different SIM and new number), the permanent export of the vehicle after an initial period of use in Ireland, or its scrapping at the end-of-life stage. Under normal conditions, it may be expected that the quantity of connected vehicle-related numbers falling out of use will follow an upward trajectory not dissimilar to that of the original demand, albeit lagging such by a period potentially as long as that of the life of the connected vehicle itself. Whilst these factors are characteristic of the mode of usage and cannot in themselves be mitigated, the implementation of suitable number recovery mechanisms, with responsibility for recovery of the number resting with the assignee, should be considered in order to avoid excess quantities of inactive numbers remaining allocated to non-operational or even non-existent vehicles.

'Upper Limit' Prediction

InterConnect's second approach to predicting likely demand for numbers reflects the fact that, with numbers for M2M applications being used on both international roaming and permanent extraterritorial bases, it is possible that demand for Irish number resources for M2M use outside Ireland could significantly exceed both in-country requirements and forecasts based on current observed

trends. Accordingly, this second approach aims to developing predictions for a potential upper limit of demand for Irish numbering resources, assuming given levels of market share.

In this case, the underlying basis for a demand prediction uses the analyses of mobile M2M connections for the period 2016-2022 published by Berg Insight, Ericsson, Cisco and Machina, subdivided into European and Global categories. Each of these has its own baseline and predicted growth index. Note that Machina only offers public-domain predictions at a global level, so InterConnect has extrapolated a corresponding set of European results by taking a notional regional baseline value proportionate to Machina's global analysis and applying Machina's global growth index.

The next stage is to recognise that not all national markets are presently open to the permanent extraterritorial use of foreign numbering resources, nor likely to be within the period under review, so depressing potential demand for Irish numbers overseas. The extent of this was estimated by summarising the results of the CEPT WG NaN questionnaire[148] relating to the permissibility of permanent extraterritorial use of numbering resources across the 20+ participating countries and factorise using the recorded numbers of M2M mobile network subscriptions[149] for each to produce an indication of the proportion of such connections actually open to permanent extraterritorial use by a number from an overseas resource. For the selection of European jurisdictions surveyed, this implied that some 45% of M2M mobile connections are currently open to using overseas numbers on a permanent extraterritorial basis[150]. Taking into account current regulatory trends, plus the provisions of the proposed European Electronic Communications Code which would require national regulators in EU Member States to determine certain numbering resources for the extraterritorial use of national numbers within the EU, in particular for M2M applications, it was assumed that this proportion would increase by equal steps to an overall figure of 90% of mobile M2M connections by 2022. At a global level, the same 45% starting point was used, but with growth increasing by equal steps to an overall figure of 60% of mobile M2M connections by 2022.

By taking these graduated proportions of accessible numbers and applying them to the Berg Insight, Ericsson, Cisco and Machina predictions of mobile M2M connections, InterConnect produced forecasts

[148] *vide* Task 1 of this project

[149] As recorded by the ITU and OECD

[150] Similarly, just over half of countries were seen to allow permanent extraterritorial use of their own resources.

for potential upper limits for M2M-related numbering resources at both pan-European and global levels. The final step was to apply a market share factor reflecting the proportion of demand which Irish numbers were considered likely to fulfil at each respective level. For Europe, in view of the relatively wide potential applicability of Irish numbers balanced by the availability of comparable resources from other European numbering authorities, and the fact that some of those countries have already adapted their regulations to allow such use, an overall market share of 5% was considered an appropriate and conservative estimate. For other global markets, this was reduced to 1% to reflect the lesser likelihood of geographically-distant administrations being willing to accept Irish (or, for that matter, other European) numbering resources for permanent extraterritorial use. These market share factors were then applied to the predictions for Europe and for the rest-of-world (global minus Europe) to produce overall upper-limit predictions of demand.

The results of this exercise may be summarised as follows:

Predicted M2M mobile connections open to permanent use of overseas numbering resource, Europe							
Open to extraterritorial	45%	52.50%	60.00%	67.50%	75.00%	82.50%	90%
Thousands	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Berg Insight	53,139	79,203	117,586	164,357	222,030	292,809	379,492
Ericsson	47,700	75,721	117,478	196,391	279,938	455,113	696,510
Cisco	91,055	141,196	214,480	320,710	473,635	692,484	1,004,089
Machina (extrapolated by InterConnect)	49,500	69,878	96,631	131,538	176,846	235,382	310,704

Table 14 Predicted M2M Mobile Connections Open to Permanent Use of Overseas Numbering Resource - Europe

Predicted M2M mobile connections open to permanent use of overseas numbering resource, rest of world							
Open to extraterritorial	45%	47.50%	50.00%	52.50%	55.00%	57.50%	60%
Thousands	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Berg Insight	126,024	175,438	239,083	317,785	412,977	528,914	669,358
Ericsson	132,300	168,314	212,825	253,915	325,731	374,770	435,660
Cisco	259,945	367,331	517,635	727,605	1,020,415	1,428,084	1,994,819
Machina	131,979	168,077	213,456	270,407	341,775	431,087	542,708

Table 15 Predicted M2M Mobile Connections Open to Permanent Use of Overseas Numbering Resource – Rest of World

Potential Upper Limit of European Demand for Mobile M2M Numbers Based on Assumed Market Share (5%) Fulfilled by Irish Resources

Thousands	2016	2017	2018	2019	2020	2021	2022
Berg Insight	2,657	3,960	5,879	8,218	11,102	14,640	18,975
Ericsson	2,385	3,786	5,874	9,820	13,997	22,756	34,826
Cisco	4,553	7,060	10,724	16,036	23,682	34,624	50,204
Machina (extrapolated by InterConnect)	2,475	3,494	4,832	6,577	8,842	11,769	15,535

Table 16 Potential Upper Limit of European Demand for Mobile M2M Numbers - 5%

Potential Upper Limit of Rest-of-World Demand for Mobile M2M Numbers Based on Assumed Market Share (1%) Fulfilled by Irish Resources							
Thousands	2016	2017	2018	2019	2020	2021	2022
Berg Insight	1,260	1,754	2,391	3,178	4,130	5,289	6,694
Ericsson	1,323	1,683	2,128	2,539	3,257	3,748	4,357
Cisco	2,599	3,673	5,176	7,276	10,204	14,281	19,948
Machina	1,320	1,681	2,135	2,704	3,418	4,311	5,427

Table 17 Potential Upper Limit of Rest-of-World Demand for Mobile M2M Numbers - 1%

Potential Upper Limit of Global Demand for Mobile M2M Numbers Fulfilled by Irish Resources							
Thousands	2016	2017	2018	2019	2020	2021	2022
Berg Insight	3,917	5,715	8,270	11,396	15,231	19,930	25,668
Ericsson	3,708	5,469	8,002	12,359	17,254	26,503	39,182
Cisco	7,152	10,733	15,900	23,312	33,886	48,905	70,153
Machina	3,795	5,175	6,966	9,281	12,260	16,080	20,962

Table 18 Potential Upper Limit of Global Demand for Mobile M2M Numbers Fulfilled by Irish Resources

As can be seen, overall upper-limit predictions vary between 21 million and 70 million numbers in 2022, dependent upon the baseline and growth scenario adopted.

The following chart demonstrates the overall prediction in graphical form:

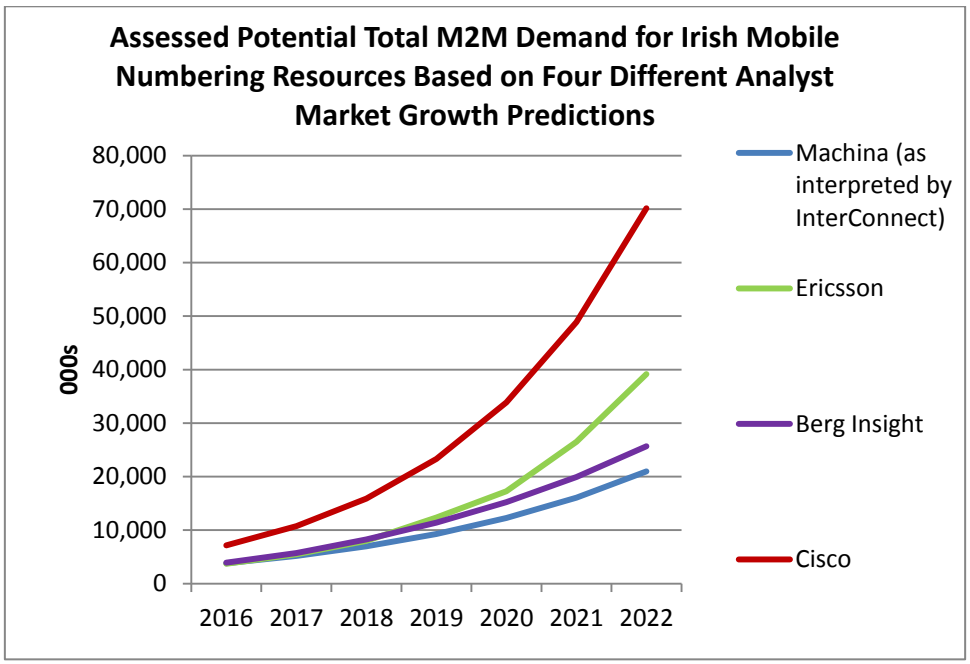

Figure 7 Assessed Potential Total M2M Demand for Irish Mobile Numbers

8.1.4 Conclusion

Based on the range of supporting market data analyses and different methodologies for translating predicted numbers of connections into likely demand for supporting mobile numbers, predicted annual requirements for Irish mobile numbers to support M2M activities in 2022 vary considerably. At a lower level, extrapolating existing indicated demand from domestic service providers using a range of growth scenarios indicates potential cumulative demand for between 2.1 million and 38 million numbers by 2022. Conversely, taking a view on the total global demand for mobile M2M connections and the extent to which such demand may be met by Irish numbering resources indicates a potential upper-level demand of between 21 million and 70 million numbers by 2022.

Under other circumstances, a variation of this extent would probably not be considered credible. In this particular case, however, it reflects a number of factors, not least underlying uncertainties in the extent of growth of the M2M market, but also the extent to which demand for numbers for applications physically based in overseas territories might be satisfied from Ireland.

At present, development of the M2M market continues to be very uncertain; while there can be little doubt with regard to levels of industry and consumer interest surrounding the whole field of M2M/IoT, there continues to be relatively little understanding of where (and to what extent) demand may fall. Some of this simply reflects market factors such as uptake, pricing, competition and market positioning. Other factors are connected with technology issues and how they may impact the form of connected products and services to be offered as well as the proportions serviced through mobile networks.

As well as suffering from a lack of clarity as to who or what will use mobile numbering for M2M applications, the global nature of the industry combined with consumer mobility and increasing (though by no means universal) regulatory acceptance of extraterritorial use of numbers makes it difficult to predict from where numbers may in practice be drawn. There are certainly only limited links between the source of allocation and geography of eventual use, with determining factors in the choice of number resource ranging from availability and price through to industry linkages and the location of managed service providers.

In many ways, the uptake of different mobile number resources for M2M usage may have much less to do with conventional numbering attributes but much more to do with the way in which countries make available numbering resources. Factors such as how many regulators may allow permanent roaming or be willing to allocate numbering resources to entities other than MNOs and MVNOs are still largely imponderable, but the eventual outcome of these matters will help determine how the demand for mobile M2M numbers evolved, and how it is satisfied.

Similarly, permanent extraterritorial use of numbering resources in areas geographically distant from those in which they originate may prove problematic from a regulatory perspective. In such a case, providers of M2M services will be influenced in their choice of numbering solutions by the acceptability of those numbers in their key markets, meaning that (for instance) the call for Irish numbers could be much stronger in some sectoral markets than others.

8.2 OTT

8.2.1 Predicted Demand for Number Resources

Despite the considerable degree of commercial and regulatory interest pertaining to the market development of Over-the-Top (OTT) services, there appears to be relatively little in the way of recent, publicly-accessible data which can be used to give an indication of the number of users of such services in Ireland. Many of the established studies in this area such as Cisco's Visual Networking Index (VNI) report and Sandvine's Global Internet Phenomena Report major on traffic volumes attributable to OTT services, while other studies focus on the market value of such services. While in themselves valid indicators of market development, these cannot readily be translated to user numbers, as both traffic volumes and revenues per user may vary significantly between products and over time.

In any case, it is dubious as to whether the growth in uptake of OTT services is in itself likely to act as a significant driver in the demand for mobile numbers. Whilst access to OTT services requires the use of smartphones, tablets or other connected devices, each of which may have its own mobile number, at present the prevailing trend is not towards the allocation of numbers to the actual services themselves. As each single connected device is likely to be used to access more than one OTT service, the proliferation of such services is unlikely to be directly reflected in the requirement for mobile numbers.

InterConnect contends that support for this assertion may be derived from ComReg's own statistics for mobile subscriptions published in its quarterly market data report for Q4 2016[151]. Between Q4 2014 and Q4 2016, the total number of mobile subscriptions (including mobile broadband and M2M) rose only marginally, from just over 5.8 million to something over 5.9 million, equivalent to an increase of just over 2.5%. The total number of mobile subscriptions excluding mobile broadband and M2M followed a similar path, while the total number of mobile voice and data subscribers using 3G and 4G networks rose from just under 4.1 million in Q4 2015 to something above 4.3 million in Q4 2016,

[151] Irish Communications Market Quarterly Key Data Report Data as of Q4 2016, document reference number 17/15r, available on-line at https://www.comreg.ie/publication-download/irish-communications-market-quarterly-key-data-report-data-q4-2016

representing a 6% year-on-year growth compared with a 5.9% year-on-year growth to the end of the preceding quarter[152].

On the basis of OTT services as classified by BEREC, OTT-1 (services complementary to telephone service such as Skype, Viber, etc) may require number resources if accepting incoming calls; OTT-0 services exchanging traffic directly with public fixed and mobile networks certainly will do. The relatively restricted increase in the number of registered mobile subscribers certainly provides no indication of any substantial growth in the adoption and use of OTT-0 mobile services.

In its 2016 report for ComReg on conservation measures in the mobile numbering space[153], Analysys-Mason projected exhaustion of Irish mobile numbers in the 083, 085, 086, 087 and 089 ranges occurring in 2023 if existing historical trends continued to prevail, with this exhaustion point perhaps being brought forward to 2019 should demand experience significant growth driven by allocation to uses such as M2M[154]. With the maximum quantity of numbers in the five-range series established at circa 39 million and ComReg data indicating that some 14.199 million numbers in these ranges remained free for assignment in January 2017, the implication is that net allocation trends up to and including Q4 2016 were continuing to run at a level similar to the lesser of Analysys-Mason's two predictions.

With the implementation of measures to secure efficiency of utilisation by service providers helping to extend exhaustion points rather than bring them closer, at predicted levels of growth present number resources should prove adequate to meet likely demand related to OTT services to 2022 (and just beyond) without the need to open-up additional number reserves. It should, however, be borne in mind that if changes in demographics, technologies, market offerings or other factors significantly alter levels of uptake for services require number resources, an entirely possible scenario given the relative newness of OTT services, this could have a significant effect upon demand for mobile numbers and any concomitant exhaustion point.

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[152] Source: Irish Communications Market Quarterly Key Data Report Data as of Q3 2016, document reference number 16/108(R), available on-line at https://www.comreg.ie/publication-download/quarterly-key-data-report-q3-2016

[153] Analysys Mason report for ComReg *Conservation measures to meet future demand for mobile numbers*, (ComReg reference number16/20a), 8th March 2016. Available on-line at https://www.comreg.ie/publication/report-for-comreg-conservation-measures-to-meet-future-demand-for-mobile-numbers/

[154] Source: Figure 3.15 Analysys Mason report for ComReg *Conservation Measures to Meet Future Demand for Mobile Numbers*, 8th March 2016

9. Annex D: Identifier Work Streams and Standards Development Organisations

9.1 Identifier overview

M2M and OTT identifiers have a number of uses including object identification, resolution and network addressing.[155] Identifiers also assist with security (through actions such as authorisation) and maintenance (through actions such as discovery and access). Technical standardisation of attributes such as these in a particular vertical may take place in a variety of standards organisations. For instance, in Intelligent Transportation Systems, the Vehicle-to-Vehicle and Vehicle-to-Infrastructure standards work is being done by organisations as varied as the ASTM, ETSI, ISO, IEEE and the IETF. The impact of this on identifiers is that there are multiple approaches to both device identification and applications layer interoperability. For example, the standards and protocols being developed in IEEE and ETSI in this area are not interoperable. This has clear implications for the use and deployment of identifiers.

Projections for numbers of internet connected devices over the next ten years vary widely with estimates ranging from 20 to 200 billion connected devices by 2020. Further complicating the ability to determine the direct impact on mobile numbering is the variety of identifier resources available to M2M and OTT technologies.

In addition to competition from proprietary identifier schemes are developed solutions such as IPv6/IPv4, Universal Resource Identifiers, RFID/Electronic Product Codes, and Ubiquitous Code (uCode) technology (currently used in Japan). Some standards organisations, such as oneM2M, are also working to provide a solution to the identifier issue by providing an intermediary platform with its own identification semantics. This “bridge” approach is also being used at the application layer for achieving interoperability between mutually incompatible systems, such as the work being done between oneM2M and 3GPP.

In many cases, the identification scheme is connected to the type of transport technology in use. Below is Table 19 with an overview of some common transport standards for M2M and how the transport relates to addressing and identification.

[155] The Internet of Things Factsheet: Identification; https://ec.europa.eu/digital-single-market/news/conclusions-internet-things-public-consultation

	Standard	Typical Identification	Frequency	Data Rate
	Bluetooth 5[156] and Bluetooth with low energy (BLE)	Bluetooth Device Address (BD_ADDR)	2.4GHz	2 Mpbs
	Zigbee	Unicast and Broadcast addresses based on the 802.15.4 standard	2.4GHz	250Kbps
	Z-Wave[157]	NodeID, 8-bits dynamically assigned by the network	900MHz	Varies: 9.6 – 100Kbps
	6LoPAN[158]	IPv6	Available over a variety of networking media	N/A
	Thread	IPv6	2.4GHz	250Kbps
	WiFi[159]	802.11 WLAN physical addresses, logical addresses based on protocol in use	2.4GHz and 5GHz bands	600 Mbps maximum
	Cellular [GSM/GPRS/EDGE (2G), UMTS/HSPA (3G), LTE (4G)]	E.164	900/1800/1900/2100MHz	35-170kps (GPRS), 120-384kbps (EDGE), 384Kbps-

156 https://www.bluetooth.com/specifications/adopted-specifications
157 http://z-wave.sigmadesigns.com/design-z-wave/z-wave-public-specification/
158 https://tools.ietf.org/html/rfc6775
159 http://standards.ieee.org/getieee802/download/802.11n-2009.pdf

				2Mbps (UMTS), 600kbps-10Mbps (HSPA), 3-10Mbps (LTE)
	Sigfox	Proprietary device ID using ETSI's Low Throughput Networks specification	868/902/923/920MHz	Very low

Table 19 Common Transport Standards and Identification

As with other identifier schemes, mobile numbering has both logical use cases and expected areas of low to no uptake. Projections can be based on types of devices, services and basic connectivity requirements. For instance, generally stationary devices such as smart home appliances and some industrial IoT networks will not require mobile connectivity, and therefore are not logical markets for mobile identifiers. However, no one category should be ruled out, as there is scope for use of mobile identifiers in stationary smart metering implementations, such as the Republic of Ireland's National Smart Metering Program.

Conversely, typical telecommunication market disrupters, such as VoIP services are not expected to have a large drain on mobile numbering resources. Yet providers of highly mobile devices, such as the automotive industry, present opportunities for major deployment of mobile numbering identifiers.

9.2 Standards Development Organisations and Identifier Work Streams

This section provides an overview of Standards Development Organisations (SDOs) working in the IoT and OTT spaces and highlight work streams that relate directly to identifier solutions. From the discussions below, it is obvious that not many SDOs are doing work related to identity for both M2M and OTT applications. While some organisations such as BEREC and ETSI have considered the use of E.164 and E.212 numbers in M2M/IoT deployments, the space is not heavily regulated or standardised.

The key takeaway is that E.164 and E.212 numbers are likely to be used in a transitional period in the next 5-8 years in applications where mobility is a necessity. However, where mobility is not a part of the fundamental M2M or OTT application, IPv6 is likely to be used for identifiers. The fact that the infrastructure and access networks for a large number of IoT services will be IP-based indicates that the

address schedule is likely to be IP-based as well. Since IPv4 does not provide the scaling required, IPv6 is the likely long-term solution for IoT addressing for many IoT services.

SDO	Identifier work (broadly)	Mention of E.164 / E.212 (specifically)	Notes
BEREC	Yes	Yes	2016 BEREC Report on enabling the Internet of Things
ETSI	Yes	E.164	ETSI TS 102 689 V2.1.1 (2013-07)
AIOTI	No	No	Minimal work in this area
ITU-T	Yes	Yes	Other activities include Digital Object Identifiers focus
oneM2M	Yes	No	OID specification
IEEE	Yes	No	XMPP focus
IETF	Yes	No	IPv6 focus
3GPP	Yes	No	URI focus
W3C	Yes	No	URI could be built from E.164 or E.212

Table 20 Overview of Identifier Work

It is widely viewed that there is currently an overabundance of SDOs working in the IoT space. Recently there have been calls for SDOs to improve their communications, particularly across similar work streams, and possibly join them together. There is also a general belief that some of the lesser known and poorly funded SDOs will exit the scene in short order. However, this does not negate the possibility of SDOs such as the ITU, ETSI and IEEE to inadvertently develop conflicting or non-interoperable standards.

Observation or engagement by public sector organisations, depending on capacity and technical expertise, such as regulators may be beneficial. In addition to general oversight of the SDO landscape, this will provide regulators with a good understanding of the current marketplace and how such standards may affect local markets. It also gives regulators and governments insight on how to develop national policies in keeping with global standards, ensuring a more open market and increasing ability to export technical solutions to global markets.

9.2.1 BEREC

The Body of European Regulators for Electronic Communications (BEREC) issued a report called "Enabling the Internet of Things" which focused on IoT technologies and their impact on regulation. As a follow up to the report from 2016, BEREC held a workshop in February 2017 that concentrated on the regulatory implications of large-scale and sustainable IoT rollouts. The presentations at the workshop demonstrated the diversity of applications and services that fall under the concept on IoT, ranging from

the driverless car to remote management if toilets in railway carriages. What the workshop showed was that flexibility by all stakeholders underpins successful deployment and benefit from IoT.

The 2016 report[160] identified areas that are crucial for the development of IoT (such as privacy, cybersecurity and standardisation) which, in many instances, are the responsibility of national and/or international authorities other than NRAs. Section 2.2 of the report dealt specifically with identifiers. BEREC limited its consideration of identifiers to two types of numbers: telephone numbers and IP addresses, however BEREC noted that the emergence of low-power, wide-area networks could have issues related to identifiers.

The 2016 BEREC report identified the following kinds of national and international numbers being used in M2M and IoT networks:

- National E.164 numbers;
- International/global E.164 numbers (CC39 882/883) assigned by the ITU;
- National E.212 IMSI (International Mobile Subscriber Identity);
- International/global E.212 IMSI with MNCs under MCC40 901 assigned by the ITU.

The BEREC report notes that 'It is very likely that in the short to medium term – and perhaps even in the long term – E.164 and/or E.212 identifiers will be used for addressing IoT devices,' regardless of increased use of IPv6 in M2M/IoT spaces. This is understood to be due to numbering's 'relative ease of implementations into existing network infrastructures.'

In terms of competition, BEREC notes at least one issue related to identifiers in the mobile numbering space. Mainly due to a compromise with the ITU-T, (Recommendation ITU-T E.212, Annex b) IoT users are not allowed assignment of MNCs because this 'is limited to MNOs and, in some countries, certain mobile virtual network operators (MVNOs).' If assignment of MNCs to IoT users was allowed, BEREC sees this as potentially '[lowering] barriers to competition in the market.' However, the IoT users would need the financial capability to operate the MNC and related activities in-house, and therefore may only affect the largest IoT users.

[160] 5755-berec-report-on-enabling-the-internet-of-things

Regarding IP addresses as identifiers on public networks, BEREC takes the view that there will be an eventual evolutionary migration to IPv6 on public networks. IPv4 is ignored because of perceived scalability problems with the address space.

Finally, the BEREC report reaches a series of conclusions:

- the alleged scarcity of E.164 numbers does not seem to be a barrier or a problem to be solved to foster the development of IoT. Anyway, the issue of possible scarcity of E.164 numbering resources should be analysed and solved by NRAs at national level, e.g. introducing a new numbering range for IoT services or increasing the mobile number resources.
- the current national regulation in several countries does not allow IoT users to be assignees of MNCs although this may be a way to ease change of connectivity provider – besides over-the-air provisioning of SIM – without having to physically swap the SIM. On this issue CEPT suggests the relaxation of the assignment criteria. Still, broadening the circle of assignees might lead to a scarcity of E.212 MNC resources since in many countries only 100 MNCs are available. A flexible approach at national level on how to solve this issue might be appropriate.
- the permissibility of the extra-territorial use of national E.164 and E.212 numbers and/or the actual possibility to develop IoT solutions based on global resources appear to be key for IoT services to be economically viable. Still, it must be ensured that public interests like security, national sovereignty etc. are not compromised. BEREC considers that the use of existing numbering resources, the extraterritorial use of numbers and the use of ITU numbers, seems to be a reasonable approach, while the introduction of a European numbering scheme does not seem to carry any significant benefits which would justify the deployment costs of setting up such a solution.

After publishing the report, BEREC continued to engage stakeholders and NRAs to discuss – amongst other things – the issues related to identifiers and M2M/IoT.[161] That continued engagement has led to the development of the workshop mentioned above and to IoT appearing as a key item in BEREC's 2017 work programme.

[161] It is perhaps worth noting that, at nearly the same time as the IoT report, BEREC published a report on OTT services. That report dealt entirely with regulatory implications of OTT services and did not discuss the implications of OTT on numbering or addressing: http://www.berec.europa.eu/eng/document_register/subject_matter/berec/reports/5751-berec-report-on-ott-services

The issue regarding scarcity of E.164 numbering resources reflects the limited number of digits that are specified in ITU-T Recommendation E.164 that numbers shall be no longer than 15 digits, coupled with questionable national approaches to number management. While extending the length of numbers could be addressed at the ITU-T, BEREC recognises that in the latter case it is for NRA's to do.

9.2.2 ETSI

ETSI emphasises its participation in OneM2M. However, ETSI does have its own technical committee called TC SmartM2M which has developed and now maintains a series of specifications for a standardised M2M platform. These standards are in three areas:

1. A statement of requirements[162]
2. A functional architecture[163]
3. A set of interface descriptions[164]

ETSI is in the process of updating the functional architecture and the interface descriptions standards. Section 8 of the service requirements document sets out ETSI's approach to naming, identification and addressing. This section is extremely short and ends with the following requirement:

> "The M2M System shall allow flexible addressing schemes, including:
>
> - IP address of CO.
> - IP address of group of COs (including multicast address).
> - E.164 addresses of CO (e.g. MSISDN)."

The architecture standard provides a more detailed look at the range of identifiers required for the ETSI M2M architecture. The standard lists seven different classes of identifiers.

Beyond their work on infrastructure standards for M2M, ETSI is spending effort on individual use cases, including smart cities, smart grids, eHealth and Intelligent Transport Systems. To support other work on M2M infrastructure ETSI is involved with standardisation for security for the Internet of Things, Low-

[162] http://www.etsi.org/deliver/etsi_ts/102600_102699/102689/02.01.01_60/ts_102689v020101p.pdf

[163] http://www.etsi.org/deliver/etsi_ts/102600_102699/102690/02.01.01_60/ts_102690v020101p.pdf

[164] http://www.etsi.org/deliver/etsi_ts/102600_102699/102690/02.01.01_60/ts_102690v020101p.pdf

power supplies in the IoT, radio spectrum requirement assessment, and embedded communications modules which are intended to simplify the integration of modules from different manufacturers in a wide range of M2M applications.

ETSI is a member of oneM2M and therefore will not set up any conflicting work, but will contribute to the work being done in the oneM2M SDO. In the area of mobile numbering, especially for OTT applications and services, ETSI integrates its work with 3GPP. The implication here is that any work related to E.164 mobile numbering will be consistent with pan-European approaches to numbering regulation.

9.2.3 EC & AIOTI

In March 2015, the European Commission launched the Alliance for Internet of Things Innovation (AIOTI) with the intent of supporting the creation of an innovative and industry driven European Internet of Things ecosystem. This flags the intention of the European Commission to work closely with all Internet of Things stakeholders and actors towards the establishment of a competitive European IoT market and the creation of new business models. At the end of 2016 AIOTI evolved to become an independent organisation, separate both functionally and fiscally from the Commission. Just before that, the Commission published a working document called "Advancing the Internet of Things in Europe[165]" as part of its preparation to implement part of the Digital Single Market Strategy[166] adopted in 2015. Today AIOTI is the largest European IoT Association.

The Commission has been rightly concerned about identifiers and numbering. In this context the Commission has found it important to promote an interoperable IoT numbering space for a universal object identification that transcends geographical limits, and an open system for object identification and authentication. Some aspects of numbering are already addressed in the 2016 review of the EU telecoms rules[167]. The Commission has also invested in research and grants related to M2M, especially in the area of large scale pilots of technology in Europe. In particular, in the autumn of 2016, the Commission launched a call for proposals on IoT large scale pilots in the areas of wearables, assisted

[165] http://eur-lex.europa.eu/legal-content/TXT/?uri=CELEX:52016SC0110

[166] http://ec.europa.eu/priorities/digital-single-market/

[167] https://ec.europa.eu/digital-single-market/en/connectivity-european-gigabit-society

living, connected vehicles, smart cities, smart agriculture and water management supported by Horizon 2020 research and innovation programme funding.

AIOTI has not yet focused much attention on numbering and addressing for IoT and M2M services and applications. Instead, its Working Group 3 has attempted to find a mechanism to describe the shared and independent features of each of the major verticals. It has then called on other standards organisations to establish effective collaborations, develop a shared standardisation roadmap, and, after adopting the roadmap, work collaboratively to identify standardisation priorities, inform programs and rationalise deliverables. This has not yet led to much work in the identifier space.

The implication for Ireland is that AIOTI is not likely to have a significant effect on numbering strategies for traditional mobile numbering ranges.

9.2.4 ITU

In the ITU, work on object identifiers is being done in a variety of Study Groups (SG) including SG2 on operational aspects of telecommunications, SG17 on security, and SG20 on the Internet of Things. Most notably, the concept of Digital Object Identifiers is being advocated by some members as a universal solution to device identity. However, many stakeholders believe a centralised, global identification system of this type is not needed for successful development of the Internet of Things due to the variety of solutions, such as mobile numbering and IPv6, already in use and in development.

Prior to the initiation of Study Group 20, the ITU did provide a draft overview for the Internet of Things. Now nearly four years old, Y.2060 was part of the ITU's Next Generation Networks series of standards. For those standards, numbering and identifier related topics were dealt with separately. As a result, Y.2060 does not touch on numbering issues for M2M. With SG20 still at a very early stage, it may be some time before we see detailed recommendations from the ITU on the specifics of M2M and its implications for numbering and addressing.

9.2.5 oneM2M

OneM2M is a SDO with 200 member organisations working to develop a common service layer for the Internet of Things. ETSI is a member of oneM2M and therefore supports work done in the SDO, acting as a two-way flow of information between European member states and oneM2M. It is recognised that

a part of this is development of a device identifier structure to support a variety of capabilities including device discovery, semantic interoperability, and security functions.

OneM2M has a very rich set of specifications that include not only detailed physical, network and application layer standards for M2M but also specifications for interworking between OneM2M compliant implementations and implementations of other standards[168] (e.g. AllJoyn).

The functional architecture for the OneM2M services platform specifies a set of twelve different identifiers for the purposes of interworking within the OneM2M model. Not all of these represent network endpoints or locators. For example the Application Entity Identifier identifies an application resident on an M2M node (or, alternatively, an application in the network that requests interaction with an M2M node). The implication is that not all of the identifiers in the OneM2M functional architecture would have an impact on numbers resources managed by ComReg.

Device Identifiers in Release 2 of the Functional Architecture of OneM2M is a globally unique identifier system which does not make use of traditional E.164 numbers. While the highest arc of the globally unique identifier is managed by the ITU-T, it is not part of the E.164 namespace.

An example of an M2M device ID based on the OID specification would be the following.

Let us assume an M2M Device ID of {0 2 481 1 100 3030 10011}. The M2M device ID can be interpreted as follows:

- (0 2 481 1) in {0 2 481 1 100 3030 10011} - represents the M2M Device Indication ID (higher arc):
    - (0) in {0 2 481 1 100 3030 10011} - identifies the managing organisation ITU-T.
    - (2) in {0 2 481 1 100 3030 10011} - identifies "Administration".
    - (481) in {0 2 481 1 100 3030 10011} - identifies the data country code for Korea.
    - (1) in {0 2 481 1 100 3030 10011} - identifies an M2M device.
- (100) in {0 2 481 1 100 3030 10011} - identifies the device Manufacturer.
- (3030) in {0 2 481 1 100 3030 10011} - identifies the device Model.

[168] http://www.onem2m.org/images/files/deliverables/Release2/TS-0021-oneM2M_and_AllJoyn_Interworking-V2_0_0.pdf

(10011) in {0 2 481 1 100 3030 10011} - identifies the device Serial number.

9.2.6 IEEE P2413

P2413 is the IEEE's working group on the Internet of Things. Its official title is "Standard for an Architectural Framework for the Internet of Things." It attempts to "provide an architecture framework which captures the commonalities across different domains and provides a basis for instantiation of concrete IoT architectures.[169]" As a result, it provides a reference architecture similar to the ones provided by OneM2M, AIOTI and the one likely to be available shortly from the ITU-T.

The IEEE's approach is driving XMPP as an IoT solution with an emphasis on connecting different (legacy) protocols to/over XMPP transport with a strong security focus (including domain federation and identity). This strategy is built on a protocol-agnostic model.

IEEE P2413 meets in January 2017 and it may be possible to provide further detail of the numbering and addressing implications of the IEEE's architectural framework after that meeting. Also, summarise the results of the IEEE World Forum on Internet of Things and its implications for OTT and IoT numbering and addressing[170].

9.2.7 IETF

The Internet Engineering Task Force is doing significant standardisation work in the area of M2M and IoT. Specifically, the IETF is working to ensure that application and network layer security can be provided for M2M applications. The IETF is also ensuring that protocols can be adapted to implementation where low-power, small frame sizes, and lower computational ability challenge deployment. Finally, the IETF is working to ensure interoperability at both the application layer and the network layer for M2M and OTT applications and services.

The fundamental approach to supporting addressing and numbering for the IETF is IPv6. The IETF has already provided an adaptation of IPv6 specifically designed for low cost and low power devices. The network types that are supported include – star, mesh, and combinations of star and mesh. The Phy

[169] http://grouper.ieee.org/groups/2413/Intro-to-IEEE-P2413.pdf

[170] http://wfiot2016.ieee-wf-iot.org/program/

and MAC layers conform to IEEE 802.15.4-2003 standard. The key characteristics of this adaptation include:

- Small packet size
- 16-bit short or IEEE 64-bit extended media access control addresses
- Low bandwidth. (250/40/20 kbps)
- Topologies include star and mesh
- Low power, typically battery operated
- Relatively low cost
- Networks are ad hoc & devices have limited accessibility and user interfaces
- Inherently unreliable due to nature of devices in the wireless medium

6LoWPAN is important because it brings the enormous size of the IPv6 address space to the constrained environment of M2M. It may also be applicable in some implementations of OTT services.

Note: a subsequent version of this document will discuss the implications of OTT applications built upon WebRTC on addressing requirements (e.g. compatibility with existing applications Skype, Viber and what it means for Alice to call Bob through their browsers).

9.2.8 3GPP

Third Generation Partnership Project (3GPP) brings together 7 telecommunications SDOs including ETSI, ARIB, ATIS, CCSA,TSDSI, TTA, and TTC. Work is separated into the following 3 Technical Specification Groups (TSGs):

- Radio Access Networks (TSG RAN)
- Services and Systems Aspects (TSG SA)
- Core Network and Terminals (TSG CT)

No one technical group in 3GPP works on identifiers specifically. TSG SA includes work items related to security, specifically 'definition of a security framework and review of security aspects of overall systems'[171] which one could assume will at least touch on the identity/identifier issues. Thus far the

[171] http://www.3gpp.org/specifications-groups/sa-plenary

work in 3GPP on identifiers has been on universal resource identification and is this focus is not expected to change[172].

9.2.9 W3C

The World Wide Web Consortium is doing a significant amount of standardisation for adapting existing web technologies for OTT applications and IoT implementations.

The W3C refers to the layer of semantics, security and metadata that will integrate M2M and OTT services as the Web of Things. Its WoT Working Group is collaborating with AIOTI, OneM2M, the IETF, and other SDOs on the development of key standards building blocks. Much of the work in the W3C is at the application layer. For instance, most forms of device discovery in the W3C's technology landscape are built on top of IP + TCP/UDP and SOAP or XMPP. In addition, the W3C's interest in security for the Web of Things concentrates on protocol standards for the authorisation of actions and the authentication of actors.

However, the implementation of OTT applications and services is significantly affected by its standardisation of WebRTC. Identity provision and assertions are built on URIs rather than numbers. However, it is important to note that an OTT application or service might still use mobile numbers in support of a URI that is built, in-part, from an E.164 or E.212 number.

[172] http://www.3gpp.org/specifications-groups/34-uniform-resource-name-urn-list

10. Annex E: M2M and OTT: Uses and Market Opportunities

10.1 M2M

Transportation, Industrial IoT (IIoT), health and wearables, smart home and appliances, and Smart Cities are key areas where M2M technologies are likely to develop quickly. This also opens market possibilities for mobile number resources. That being said, only a small portion of M2M communications are expected to be enabled via cellular technologies, meaning a fraction of all devices will require a SIM and mobile numbering resources[173]. Therefore it is important to understand the ecosystem and technological developments which may draw down on those finite resources to create markets and maximise value. This Annex reviews popular areas of M2M and IoT technology development as well as possible areas of interest to the mobile industry.

10.1.1 Transportation

In a recent study, the automotive and transportation sector is projected to 'account for 60% of total cellular M2M connections' between 2014 and 2025, reaching approximately 900 million connections by 2025[174]. A survey of developers found automotive in their top third of most popular consumer development areas, with over 20% working on related solutions.[175] It is evident that this sector is poised to develop quickly in the M2M space and could be the largest opportunity for and drain on mobile numbering resources.

The sector, compared to others such consumer appliances, is also fairly advanced in discussions among manufacturers and regulators to try and develop interoperable, long-lasting, safe consumer technologies. There is great engagement not only by industry, but also national policymakers and regulators creating new rules and regulations. For example, the United States Department of

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[173] *BEREC Report on Enabling the Internet of Things*, p.4, 16 February 2016, 5755-berec-report-on-enabling-the-internet-of_0.pdf

[174] Analysys_Mason_m2m_iot_operator_opportunities_vol2_oct2016.pdf , M2M and Internet of Things (IoT): Opportunities for Telecoms Providers

[175] Eclipse, *IoT Developer Survey*, April 2015: http://www.slideshare.net/IanSkerrett/iot-developer-survey-2015

Transportation Federal Automated Vehicles Policy[176] was the first of its kind to define an 'automated vehicle,' In addition, the Department of Transportation has chosen 10 US cities as 'proving grounds' for the rapid advancement of self-driving car technologies[177].

While connected cars are already in the market and will use mobile numbering resources, the move to self-driving cars and resources required for this technology may lag behind other countries like the U.S., England, Germany and France who have all taken steps to advance autonomous technology.

In the transportation space, identifiers will be used for a variety of devices. Mobile numbering is most likely to be in SIMs and eSIMs for connected and automated vehicles to provide ubiquitous mobile connectivity to the manufacturer as well as a Wi-Fi hotspot for the user. Current discussion regarding the use of SIMs in connected cars is focused on one SIM providing all the required connectivity for the vehicle – for either manufacturer or consumer use. However it is possible that a market for two mobile identifiers in a consumer vehicle will develop – one customer-facing and another manufacturer-facing. A manufacturer-facing SIM would provide connectivity for the transfer of data both for driving resources and car monitoring. However, the consumer-facing services such as Wi-Fi hotspots may result in consumers preferring to have control over which network provides this service due to reduced cost or better service speeds and coverage based on a driver's location and commonly visited places (i.e. regularly crossing international borders).

Connected cars[178] are a rapidly developing use case for mobile numbering in this sector with most manufacturers already offering some level of related technologies. It could expand to other modes of transport such as trains and public transit – which will be discussed in the Smart Cities section. Therefore the growth of automated and assisted driving technologies will have a large impact on the near and long term need of mobile identifiers in this space.

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[176] U.S. Department of Transportation, Federal Automated Vehicle Policy, accessed 10/1/1: https://www.transportation.gov/AV

[177] 'U.S. Department of Transportation Designates 10 Automated Vehicle Proving Grounds to Encourage Testing of New Technologies,' U.S. Department of Transportation, 19 January 2017, https://www.transportation.gov/briefing-room/dot1717

[178] When monitoring the connected cars sector for developments relative to M2M mobile numbering, it is worth noting that some organisations include connected cars in the smart home space. This means regulations, policies, and technical developments relevant to connected cars may be placed in and managed in the smart home vertical.

10.1.2 IIoT

The Industrial Internet of Things (IIoT), also known as Industry 4.0, is a fast-growing market, ranking second in popularity with developers (behind home automation)[179]. Growth in the IIoT marketplace will be driven by a variety of factors. This includes improvements in technologies such as cloud computing, virtualisation and data analytics tools. Increased capability and accuracy along with decreased cost of sensors will also play a role here. And an increase in connected sensors and devices only highlights the need for identifier solutions for both operation and security.

Counteracting this movement, industry has a variety of barriers to growth in this area, including lack of standardisation and interoperability, security and privacy issues, legacy equipment and uncertain returns on investment. That being said, some industries are increasing investment in M2M and IoT solutions more than others. Utilities such as oil and gas, transportation, manufacturing and cargo are sectors to watch.

Much of IIoT will be relatively stationary, located in factories or on shop floors and will most likely not require mobile numbering. However, items or vehicles regularly on the move would be a possible area for mobile numbering market growth. For instance, eSIM capabilities in shipping containers is a popular example of where this market will grow, but could equally be used on rail freight cars and autonomous vehicles on large industrial sites such as mines. The shipping containers would require permanent roaming, while train and site-specific vehicles in Ireland most likely would not.

Developing the shipping container example, in Quarter 3 of 2015, 174,791 twenty-foot equivalent units (TEU) were lifted off or on to ships in Ireland's ports[180]. This number was up from 6% in the same quarter of 2015. Roll on/off units numbered 267, 782 for Q3 2016, a 5% increase on the same quarter in 2015. This produces a maximum of 442,573 shipping containers transferring through Irish ports in Q3 2016 alone. Reviewing data spanning 2013-2016, overall container numbers have been on a slow and steady rise, signifying a possible steady increase in mobile numbering resources. It is not clear how many of these containers are owned and operated by companies based in the Republic of Ireland. Even

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[179] *IoT Developer Survey*, Eclipse, April 2015: http://www.slideshare.net/IanSkerrett/iot-developer-survey-2015

[180] Irish Maritime Development Office. "Quarterly Statistics," accessed 27 January 2017: http://www.imdo.ie/home/site-area/statistics/quarterly-statistics/quarterly-statistics

just 1% of this number equates to 4,426 containers in 2016 which could use Irish mobile numbering resources and global roaming capabilities.

10.1.3 Health and Wearables

Wearables such as fitness trackers and watches are some of the earliest IoT devices to have significant consumer uptake. Accenture predicts wearable fitness devices will rank fourth in overall IoT solution adoptions, projecting a 20% growth in adoption by 2019[181]. While this area is set for growth in the coming years, it is not expected to have a significant impact on the M2M mobile numbering market.

Wearables such as FitBits or implants like insulin pumps use services such as Bluetooth and Wi-Fi for connectivity and are not expected to require the remote services provided by mobile operators. The trending interface for such devices is mobile phones and tablets, but they will continue to acquire numbers through the traditional service provider route.
That being said, some wearable devices coming to market include remote access and tracking capabilities, particularly for the elderly living alone or at risk of becoming lost[182]. An eSIM could be used in such a device to 'waken' it and track the location of the missing person at a given time. This would allow for greater privacy – a difficult issue in patient care and tracking – and not entail continuous tracking of the individual, while at the same time enabling remote accesses when required.

10.1.4 Smart Home and Appliances

Smart homes and appliances is an area of early solutions, but not necessarily high adoption rates. Studies have shown that consumers are generally unaware of IoT devices available to them, with 62% of US households unaware that IoT devices such as connected appliances were on the market.[183]

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[181] Accenture, The Internet of Things: The Future of Consumer Adoption, 2014: https://www.accenture.com/t20150624T211456__w__/us-en/_acnmedia/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Technology_9/Accenture-Internet-Things.pdf

[182] *Which tech can I use to keep an eye on an ageing parent?*, The Guardian, 3 July 2014, https://www.theguardian.com/technology/askjack/2014/jul/03/what-tech-can-i-use-to-keep-an-eye-on-an-aging-parent

[183] The Stevenson Company, Guys, I Think My Fridge is Smarter Than Me – IoT Adoption Rates, 18/11/17: https://stevensoncompany.com/iot-adoption-rates/

Currently, consumers are showing higher interest in home security and energy-focused solutions such as fire and CO_2 alarms, home hubs and smart meters, than the likes of a connected appliance (i.e. smart kettle or refrigerator).[184] In addition to awareness, perceived value and return on investment are current barriers to broader adoption of IoT solutions. Nevertheless, it is projected that two-thirds of consumers will purchase an in-home IoT device by 2020[185] and Consumers International project homes will have up to 50 connected devices by 2022[186].

Market growth in this sector could provide mobile operators opportunities, including variety of connectivity options, dual home Wi-Fi networks (one for communications and entertainment, and another for M2M functionalities), and mobile devices. The predominant interface for consumer smart home solutions is via mobile devices such as smart phones and tablets. However, the need for additional consumer-facing mobile numbering resources in this space is limited.

The greatest opportunity for mobile numbering resources is business -facing. Manufacturers that offer warranties, maintenance contracts, and other services to the consumer that require regular monitoring or updating of the device may find mobile numbering a legitimate identifier option. For example, a dish washer made in Ireland may be installed anywhere in the world(which therefore may require permanent roaming). Mobile numbering offers not only an identifier solution to manufacturers, but also remote provisioning via eSIM technology and can be 'awakened' at any time to accesses the required data.

From 2011 to 2013 production value of manufacturing of domestic appliances in Ireland fell almost 20%, however in 2013 the value was still 63.3 million Euros[187]. While this accounted for less than half a

[184] GSMA, GSMA: The Impact of the Internet of Things: the connected home, 2015: http://www.gsma.com/newsroom/wp-content/uploads/15625-Connected-Living-Report.pdf

[185] Accenture, The Internet of Things: The Future of Consumer Adoption, 2014: https://www.accenture.com/t20150624T211456__w__/us-en/_acnmedia/Accenture/Conversion-

[186] Consumers International, The Internet of Things and challenges for consumer protection, 11/4/17: http://www.consumersinternational.org/news-and-media/news/2016/04/new-report-internet-of-things/

[187] Statista. "Production value of the manufacture of domestic appliances in Ireland from 2011 to 2013 (in million Euros)," accessed 27 January 2017: https://www.statista.com/statistics/542268/production-value-domestic-appliances-manufacturers-ireland/

percent of Ireland's Gross Domestic Product in 2013[188], this figure still covers a large number of production units annually. It is suggested that production unit numbers and possible offerings in this space to business customers be further explored by mobile numbering providers.

10.1.5 Smart Cities

The Smart City concept is developing with great help from the Internet of Things. There are a variety of implementations that city councils and utilities are currently adopting. This could include anything from smart meter initiatives (such as the National Smart Metering Program in Ireland, currently in the design and procurement stage) to using health and social service data in new ways to provide better public services. In the Republic of Ireland there are at least 7 Smart City initiatives (Cork, Dublin, Limerick, Galway, Waterford, Belfast and Derry) and two regional smart city initiatives (Smart Dublin and Cork Smart Gateway)[189], providing potential need for mobile connectivity and numbering resources.

A possible use case for mobile numbering in the Smart City arena is via transportation authorities. Many cities are aiming to improve traffic flows, provide more efficient transportation services, and increase air quality for their citizens. This includes the use of sensors on mobile objects such as buses and trams, greater connectivity with stationary objects such as bus stops, and communications with citizens on-the-go via applications. Connecting legacy equipment may require the city council to obtain resources directly from service providers, requiring SIMs and mobile numbers. Newly purchased equipment is likely to provide connectivity via the product manufacturer and their contracts with service providers. Mobile networks and the associated numbering capabilities could play an integral role in enabling these public initiatives.

Smart meters will require connectivity but not necessarily continuously. A resource that can be used to call a meter and access information at regular intervals may be sufficient and provide a market opportunity for mobile number providers. However, current deployments in this area show a preference for connectivity via internet protocols and IPv6 identifiers. Therefore, this will prove to be a difficult sector for mobile resources to break into.

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[188] The World Bank. "GDP (current US$)," accessed 27 January 2017: http://data.worldbank.org/indicator/NY.GDP.MKTP.CD?end=2015&locations=IE&start=1960

[189] 'Launch of All Ireland Smart Cities Forum,' Smart Dublin, 20 December 2016, http://smartdublin.ie/launch-ireland-smart-cities-forum/

10.2 OTT & Wi-Fi Calling

10.2.1 Internet Companies

Internet companies have proliferated with the uptake of mobile communication technologies, especially mobile devices such as the smart phone. The services and content provided over networks, whether mobile or fixed, are generally known as over the top (OTT) services. OTT services not only tax networks with heavier payloads (either through mass amount of messages or heavier data packets such as voice and video streaming) but also present the greatest challenge and competition to traditional telecommunications providers such as mobile operators. These OTT services have quickly evolved from predominantly VoIP and text messaging services to include video chatting and photo and video messages.

A study by Statista of the most popular messaging applications (or apps) worldwide found a total of 4.4 billion monthly users as of April 2016[190]. Of the ten messaging applications included, the top five apps claim 86% of monthly users, with WhatsApp leading the pack with 1 billion users, and Facebook Messenger a close second with 900 million users. QQ Mobile, WeChat, and Skype followed respectively. At this time, it is broadly thought unlikely that internet companies would develop a significant need for mobile numbering resources apart from current uses.

10.2.2 Mobile Operators

With the continued rollout of Long Term Evolution (LTE) systems and competition from internet companies offering video and messaging services, mobile operators are in a position to not only offer better, widespread service to customers but also compete for communications solutions. Increasingly, operators are providing Voice over Wi-Fi (VoWiFi) services to customers, a complimentary technology to Voice over LTE (VoLTE) with an end goal of devices being able to seamlessly switch between Wi-Fi and LTE networks providing the best possible quality of service.[191]. The number of VoWiFi services

[190] Statista, Most popular mobile messaging apps worldwide as of April 2016, based on number of monthly active users (in millions), accessed 5/1/17: https://www.statista.com/statistics/258749/most-popular-global-mobile-messenger-apps/
[191] GSMA, VoWiFi, accessed 9/1/17: http://www.gsma.com/network2020/technology/vowifi/

commercially available increased from 13 across 8 countries in 2015[192] to 50 across 31 countries by the end of 2016[193]. VoWiFi is a part of the Wi-Fi First options offered by internet companies and carriers. Wi-Fi First also includes video and messaging communications over the internet.

Country	Carrier	Launch Date
Belgium	None	n/a
Denmark	Telenor	7 Dec 2016
	3	22 March 2016
Germany	O2 (Telefonica)	30 June 2016
	Deutsche Telekom	24 June 2016
	Vodafone	31 May 2016
The Netherlands	Vodafone	21 November 2016
Norway	Telenor	2 August 2016
Singapore	M1	22 September 2016
	SingTel	16 September 2016
United Kingdom	3	22 September 2016
	Vodafone	16 September 2016
	EE	10 April 2015
	O2	
United States	AT&T	8 October 2015
	T-Mobile	17 September 2014
	Sprint	9 April 2015
	Verizon Wireless	8 December 2015
	Republic Wireless	
	Google Project Fi	

Table 21 VoWiFi Launches Through December 2016[194]

Some internet companies offering VoWiFi service provide consumers the option of using mobile numbers. One such service is Skype. However, uptake of numbering services via Skype is low and not expected to grow exponentially. Service providers such as WhatsApp and iMessenger calling do not offer numbering options to users and use account information to connect to customer devices.

	Are VoIP providers entitled to obtain telephone numbers or network identifying numbers?	Is number portability required of VoIP providers?	Are there wholesale mobile termination rates for VoIP/ mVoIP/VoWiFi calling?	Are VoIP/mVoIP/VoWifi services required to provide access to emergency numbers?
Belgium	Yes (geographic numbers)	Not known		
Denmark	Yes, providing that they meet the appropriate requirements of the Numbering Plan.	Yes –if using numbers from NNP	Not regulated?[195]	Yes, if allowing calls to national numbers[196]

Germany	Yes (if user has business or residence in the area code for the requested geographic number)	Yes	Subject to regulation but only where using numbers from NNP?[197]	Yes, if classified as a Publicly Accessible Telecommunications Service (PATS)
Netherlands	Yes (in connection with certain requirements)	Yes –if using numbers from NNP	Subject to regulation but only where using numbers from NNP?[198]	Yes, if classified as a Publicly Accessible Telecommunications Service (PATS)
Norway[199]	Yes (if full mobile telephone service[200])	Yes		Yes (if calls to domestic numbers is permitted, are treated as mobile network calls)
Singapore	Yes – Level '3' (IPT only) or Level '6' (IPT/PSTN) numbers if Facilities-Based Operator (FBO) licensee, Level '3' numbers only if Service-Based Operator (SBO) licensee,.	Yes (for VoIP operators using level '6' numbers)		Yes, if using Level '6' numbering resources (IPT/PSTN)[201].

Table 22 VoIP and Numbering

Other uses of VoWiFi technologies, particularly by mobile operators, is not expected to draw on mobile numbering resources. This is due to the fact that VoWiFi services are connected to a user's account and

[192] GSMA, Mobile Policy Handbook: An insider's guide to the issues, 2016.

[193] GSMA, Coverage Map & Statistics, accessed 9/1/17: http://www.gsma.com/network2020/resources/all-ip-statistics/

[194] GSMA, Network 2020, VoWiFi Launches, updated 31/12/16, accessed 9/1/17: http://www.gsma.com/network2020/wp-content/uploads/2017/01/Network-2020-VoWifi-launches-31-December-2016.pdf

[195] http://www.cullen-international.com/asset/?location=/content/assets/research/presentations/the-regulation-of-voip-in-europe---trends-across-member-states---eu-commission-2008---cullen-international.pdf/the-regulation-of-voip-in-europe---trends-across-member-states---eu-commission-2008---cullen-international.pdf

[196] Ibid

[197] Ibid.

[198] Ibid.

[199] http://eng.nkom.no/market/numbering/numbering/numbers-for-land-mobile-services/_attachment/18107?_ts=14d56a53da3

[200] A 'full mobile telephone service' is a service that is able to offer incoming and outgoing voice services using numbers from the national number plan, ordinary SMS functionality, and data services, offer close to equivalent mobility (access to VoLTE/3G and 4G data or equivalent type of service if VoWiFi is not available)

[201] See https://www.imda.gov.sg/~/media/imda/files/regulation%20licensing%20and%20consultations/licensing/licenses/ipteltcs.pdf?la=en

existing mobile number, aiming to provide a higher quality of service to customers than can be obtained using internet company OTT services.

11. Annex F Acronyms and abbreviations

3GPP	3rd Generation Partnership Project
ACM	Authority for Consumers & Markets (Netherlands regulatory authority)
ASTM	An international standards organization developing and publishing voluntary consensus technical standards for a wide range of materials, products, systems, and services
BEREC	Body of European Regulators for Electronic Communications
BIPT	Belgian Institute for Postal services and Telecommunications
BNetzA	Bundesnetzagentur (German regulatory authority)
CAGR	Compound Annual Growth Rate
CCC	Country Code
CEPT	European Conference of Postal and telecommunications Administrations
CLI	Calling Line Identity
ComReg	Commission for Communications Regulation (Irish regulatory authority)
CSO	Central Statistics Office of Ireland
EC&AIOTI	European Commission & Alliance for Internet of Things Innovation
ECC	Electronic Communications Committee
ECS	Electronic Communication Services
EECC	European Electronic Code of Conduct
ENS	Danish Energy Agency (Danish regulatory authority)
eSIM	Embedded Subscriber Identity Module
ETSI	European Telecommunications Standards Institute
EU	European Union
FBO	Facilities-Based Operator (Singapore)
GDP	Gross Domestic Product
GPS	Global Positioning System
GSMA	Groupe Spéciale Mobile Association
GSM-R	Global System for Mobile Communications – Railway
HLR	Home Location Register
ICT	Information and Communication Technologies
IEEE	Institute of Electrical and Electronic Engineers
IETF	Internet Engineering Task Force
IIN	Issuer Identification Number
IIOT	Industrial Internet of Things
IMDA	Infocomm Media Development Authority (Singapore regulatory authority)
IMSI	International Mobile Subscription Identifier
IoT	Internet of Things
IP	Internet Protocol
IPT	IP Telephony (Singapore)
ISDN	Integrated Services digital Network
ISO	International Organization for Standardization
ITU	International Telecommunications Union

LTE	Long Term Evolution
M2M	Machine to Machine
MCC	Mobile Country Code
MNC	Mobile Network Code
MNO	Mobile Network Operator
MVNA	Mobile Virtual Network Aggregator
MVNE	Mobile Virtual Network Enabler
MVNO	Mobile Virtual Network Operator
mVoIP	Mobile VoIP
NFV	Network Function Virtualisation
Nkom	Norwegian Communications Authority
NNP	National Numbering Plan
NP	Number Portability
NRA	National Regulatory Authority
OECD	Organisation for Economic Co-operation and Development
OSS	Operational Support Systems
OTA	Over the Air
OTT	Over the Top
OTT-0	BEREC classification for OTT services acting as a replacement for electronic communication services (ECS)
OTT-1	BEREC classification for OTT services acting as a potential competitor electronic communication services (ECS)
OTT-2	BEREC classification for OTT services not within the OTT-) or OTT-1 categories
P2P	Person-to-Person
PLC	Power-Line Communication
PSAP	Public Safety Access Point
PSTN	Public Switched Telephone Network
PVNO	Private Virtual Network Operator (Netherlands)
RFID	Radio-Frequency Identification
SBO	Services-Based Operator (Singapore)
SDO	Standards Development Organisation
SIM	Subscriber Identity Module
SMS	Short Message Service
SP	Service Provider
TACS	Total Access Communication System
TKG	German Telecommunications Act
TNGebV	German Telecommunications Fee Regulation
VNI	Cisco Visual Networking Index
VoIP	Voice over Internet Protocol
W3C	World Wide Web Consortium
WG NaN	CEPT ECC's Working Group on Numbering and Networks

12. Annex G: List of Figures