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Executive Summary

Introduction

During the last 20 years, the Internet has changed the way in which we work, communicate and trade. We are now on the cusp of another industrial revolution that will have a significant, positive impact on a wide range of industry sectors, including energy, transport, manufacturing and health. It is described by terms such as “Machine-to-Machine Communication” (M2M) or – the somewhat different notion of – “Internet of Things” (IoT) and involves a large number of devices communicating often automatically with one another primarily across the Internet using fixed and mobile access networks.

This document gives BEREC’s survey and assessment of the state of play on M2M services with the perspective of fostering an environment that will result in sustainable competition, interoperability of electronic communications services and consumer benefits. It is aimed at presenting the most common M2M characteristics and assessing whether M2M services might require special treatment with regard to current and potential future regulatory issues. Some suggestions by BEREC addressed to NRAs – where possible – are included on how to deal with them.

M2M services are in varying phases of development and take various shapes, hence there is not yet a common understanding or definition of what M2M services and devices really are. For the purposes of this report, it is not necessary to determine in a detailed manner which definition is most appropriate. For a better understanding of the M2M phenomenom typical examples of an M2M value chain are given involving the main market players such as connectivity service providers, M2M service providers, M2M users and end-users. Market players may have several roles.

Current M2M services broadly share some of the following characteristics: automatic communication of data from remote devices, relatively simple devices, low volume traffic, connectivity for M2M services required (though accounting for a relatively low proportion of the overall revenue opportunity in the M2M value chain), provided via devices designed and produced for the world market and for usage based on global mobility, a number of M2M devices with a lifetime of many years, business model B2B or B2B2C.

The report looks at preconditions for M2M services to thrive. Different authorities might help in establishing these. As set out below they include assuring adequate resources for M2M services (spectrum, numbers, IP adresses), an EU Telecommunications Framework fit for M2M services and consumer acceptance of M2M services depending on transparency, privacy, data security, interoperability of services, devices and platforms.

This report assesses issues regarding mobile network based M2M solutions in more detail since those have been primarily addressed by stakeholders. However, it has to be stressed that many M2M applications exist or may be developed which are based on another kind of connectivity (including fixed and another kind of wireless connectivity) than mobile connectivity.

Several questions are addressed to stakeholders in order to obtain feedback on issues where BEREC would like to get a better understanding of the requirements of the market (cf. questions in the text on pages 11, 19, 23, 27 and 29 which are summarized in Annex 3).

Ensuring adequate resources for M2M services

Spectrum

A range of technology options are likely to be used to deploy M2M services. Given the variation in maturity in the evolution of the M2M market across Member States, NRAs should monitor market developments and spectrum use. For the benefit of harmonization, industry is invited to make use of the established processes via ETSI and CEPT if it identifies the demand for additional spectrum. Based on these harmonized European Standards and frequencies, NRAs are invited, where appropriate, to make spectrum available to support these applications.

Identifiers

The identifiers used for M2M applications in public networks are: E.164 (e.g. MSISDN) and E.212 (IMSI) numbers as well as IPv4 and IPv6 addresses. In the short and medium term – and perhaps even in the long term – classical telecommunications numbers (E.164 and E.212) will continue to be one solution to identify M2M entities. In the longer term, the use of IPv6 addresses might become the preferred solution.

Many of the numbering issues NRAs currently have to tackle – and which are primarily dealt by CEPT and/or ITU on an international level – concern M2M services based on mobile connectivity:

Firstly, 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 M2M. Anyway, the issue of possible scarcity of E.164 numbering resources should be analysed and solved or mimimized by NRAs at national level, e.g. introducing a new numbering range for M2M services or increasing the mobile number resources namely increasing the number length of new number ranges.

Secondly, mainly due to an harmonization compromise within ITU-T, the current national regulation in several countries does not allow M2M users to be assignees of MNCs, although this may be a way to ease change of connectivity provider – besides over-the-air (OTA) provisioning of SIM – without having to physically swap SIM cards (cf. section 3.3). 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.

Thirdly, the permissibility of the extra-territorial use of national E.164 and E.212 numbers (i.e. the use of national numbers in a foreign country and vice-versa) and/or the actual possibility to develop M2M solutions based on global resources appear to be key for M2M services to be economically viable. Still, it must be ensured that public interests like security etc. are not compromised.

With regard to IP addressing, the IPv4 addressing structure provides an insufficient number of publicly routable addresses to provide a distinct address to every Internet device or service (however, many connected devices may be located behind one IPv4 address), in particular in view of the expected growth of the market. Therefore, migration to IPv6 appears to be advisable to enable the accessibility of connected devices from the public network.

M2M in the context of the EU Telecommunications Framework

Applicability of the electronic communications regulatory framework

At national level, stakeholders sought clarification from NRAs with regard to the applicable EU regulatory framework (e.g. notification regime) in the M2M value chain. This, in turn, mainly depends on the finding of an electronic communication service (ECS) according to Art. 2 lit. c Framework Directive.

Under the present regulatory framework, the connectivity service provider who provides connectivity over a public network for renumeration is generally the provider of an ECS in the M2M value chain; he is responsible vis-à-vis NRAs for the compliance with the obligations deriving from the EU regulatory framework. In contrast, the M2M user (e.g. car manufacturer, provider of energy including smart meter) typically does not seem to provide an ECS. According to such an approach, M2M users would not be subject to the rules of the EU regulatory framework. However, there would be a finding of an ECS if the M2M user wholly or mainly resells connectivity to the end-user. Overall, since there are so many different types of packages including connectivity and since business models are just beginning to evolve, it has to be carefully assessed by NRAs in which situations an M2M user may – or may not be – be qualified as a provider of an ECS.

Within the review process it should be assessed whether and, if so, to what extent the existing rules which were primarily construed for voice telephony do also fit to M2M communications or not. Also possible regulatory costs and/or the possible number of notifiable market players should be taken into account and be balanced against possible benefits for end-users.

Roaming

The M2M sector has evolved to be a transnational market of services where a significant part of the mobile devices supporting those services are conceived for global mobility, not only under the basis of temporary mobility but to be marketed globally on a permanent roaming basis. In this context, the possibility and the economic terms under which such connections can be provided are fundamental for the development of the sector.

Whereas many M2M services are nowadays based on connectivity which makes use of permanent roaming, the Roaming III Regulation is unclear regarding (i) the admissibility of permanent roaming as such as well as (ii) its applicability of the Roaming III Regulation to these situations. The Roaming III Regulation does not explicitly prohibit permanent roaming, nor explicitly permit it. Whether the Roaming Regulation is applicable to permanent roaming in the M2M context, depends mainly on the elements “travelling in the Union” and “mobile device”. Against this background a case-by-case evaluation and legal interpretation should be envisaged taking into consideration the specific (technical) details and parameters of the respective M2M service in light of the purpose of the Roaming III Regulation. However, any case-by-case approach carries legal uncertainty. In contrast, the Proposal of the European Parliament and of the Council concerning amendments to the Roaming III Regulation explicitly mentions permanent roaming; the new provisions suggest that operators may include conditions in the reference offers to prevent permanent roaming. However, it is noted that these provisions do not differentiate between person-to-person communications and M2M communications (i.e. they do not foresee any special treatment for M2M communications). Therefore, further clarification in the Roaming Regulation and/or in a Commission Communication as to (i) the admissibility of permanent roaming in the M2M context and (ii) the application of the Roaming Regulation to permanent roaming in the M2M context might be helpful.

With regard to M2M roaming agreements, BEREC notes that, on the basis of the available data, there are no issues such as refusal to conclude roaming agreements or tariffs exceeding the price caps under current regulation conditions. However, debates concerning obligation to grant or a right to refuse access might occur in the future if RLAH applies. Furthermore, on certain national markets there seem to be competition distortions stemming from the fact that the roaming operator could benefit from the coverage of all the visited networks, while visited networks in the absence of national roaming are often prevented from doing so themselves. The use of permanent roaming might in some instances reflect the absence of national roaming.

Any possible further revision and/or clarification of the Roaming Regulation should take into account the specific M2M context. Considering that M2M connectivity services might be a truly single European market, BEREC notes that permanent roaming is currently used for the provision of a number of M2M services and might facilitiate the creation of such a market. Apart from that, the rationale for permanent roaming differs in the case of, on the one hand, person-to-person communication and, on the other hand, M2M communication. In the context of the review of the wholesale roaming market review to be finalized by the Commission in mid-2016, it might be worthwhile to consider an access right for M2M permanent roaming (however subject to no wholesale cap control or certain wholesale cap levels). Given that the Roaming III Regulation is a consumer protection instrument, one might even consider to regulate permanent roaming in the M2M context in a different regulatory set.

Switching / lock-in issue

If a customer intends to change connectivity service provider, it is currently necessary that the SIM is replaced physically. The costs of doing so might prevent switching the connectivity service provider (lock-in). Remote re-programming of SIM over the air (i.e. OTA provisioning) in order to switch connectivity service provider remotely is likely the key to mitigate the lock-in issue of the M2M value chain by dropping the cost of dispatching technician to upgrade M2M devices. NRAs could have good reasons to become active on this issue as connectivity service providers have little incentive to introduce it themselves.

A review of Art. 30 of the Universal Service Directive might be appropriate, both in view of facilitating a provider switch as well as with regard to the applicability of number portability in the M2M context.

Network security

National legislation of a Member State concerning network security does not specifically address M2M services. All obligations apply also to M2M services provided that they are considered ECS or to the ECS which is underlying any M2M service.

Areas where NRAs can have a coordinating function

Privacy

Personal data may be collected by a number of connected devices such as smart meters, health applications etc. The fact that the data is transmitted and shared via M2M communication does not change its qualification as personal data.

The respect and protection of end-users' privacy is a critical success factor for the realisation of the prospects and growth of M2M services. If users do not trust that their data is being handled appropriately there is a risk that they might restrict or completely opt out of its use and sharing, which could impede the successful development of M2M.

While the general rules of the Privacy Directive (Directive 95/46/EC) are not sector-specific and apply in general, the rules of the ePrivacy Directive (Directive 2002/58/EC as amended by Directive 2009/136/EC) apply to the processing of data from both individuals and legal persons in connection with the provision of publicly available electronic communication services in public communication networks in the Community.

There are no specific rules in these two directives with regard to M2M services as such.

As to now, BEREC has not identified a need to deviate from the basic principles of data protection law in the M2M context, i.e. no need for a special treatment of M2M services. However, with regard to certain M2M services it might be worthwhile to consider rules which are adapted to the M2M environment. For example, rules on information and consent should be made as user-friendly as possible.

Standardisation

Standards play a significant role in the development of M2M technologies as they define openness, interoperability and ultimately competitiveness in the M2M environment. Standardisation bodies are already addressing the issue of standardisation in the M2M environment in a significant manner. The role of NRAs and European Union institutions over standardisation matters is to be defined in this respect but also in regard of their respective capacity to address standardisation issues respecting technological independence principle.

1. Introduction

During the last 20 years, the Internet has changed the way in which we work, communicate and trade. We are now on the cusp of another industrial revolution that will have a significant, positive impact on a wide range of industry sectors, including energy, transport, manufacturing and health. It is described by terms such as "Machine-to-Machine Communication" (M2M) or – the somewhat different notion of – "Internet of Things" (IoT) and involves a large number of devices communicating with one another primarily across the Internet using fixed and wireless access networks. In this report, the terms M2M and IoT are used as synonyms.

The market for M2M is expected to grow significantly. In a recently published report by the EC, it is expected that the IoT market in Europe will expand with yearly growth rates over 20% in value between 2013 and 2020. The number of IoT connections within the EU28 is expected to increase from approximately 1.8 billion in 2013 (the base year) to almost 6 billion in 2020. IoT revenues in the EU28 will increase from more than €307 billion in 2013 to more than €1,181 billion in 2020, including hardware, software and services. The IoT growth will involve all the Member States, but those with higher accumulated IT investments and advanced telecom networks will grow faster.[1] With this growth comes the potential to deliver significant benefits to consumers, businesses and society, through improvements in inter alia transport, healthcare and the environment.

In 2014, BEREC collected the experience of national regulatory authorities (NRAs) (i.a. by analyzing publicly available reports or other statements) on these new developments and held stakeholder interviews in order to gather facts and to get an understanding of the issues raised.[2]

Purpose/aim, scope and limitation

This document gives BEREC's survey and assessment of the state of play on M2M services with the perspective of fostering an environment that will result in sustainable competition, interoperability of electronic communications services and consumer benefits. It is aimed at presenting the most common M2M characteristics and assessing whether M2M services might require special treatment with regard to current and potential future regulatory issues. Some suggestions by BEREC addressed to NRAs – where possible – are included on how to deal with them.

The scope of this report, the detailed topics contained within it and suggestions for how areas of work may be taken forward will in part be constrained by the specific duties that fall to the various NRAs. Consequently, the report deals only to a certain extent with issues which, depending on the country, are not or not entirely within the NRAs' remit (such as privacy and standardisation).

Terminology

M2M services are in varying phases of development and take various shapes, hence there is not yet a common understanding or definition of what M2M services and devices really are. Please note that the notion "service" is used throughout the entire document, including this chapter, to explain the service provided in the M2M value chain but not in the meaning of the definitions laid down in the ITU Radio Regulations[3]. In the latter context, the notion "M2M application" would be more appropriate. Moreover, the notion "M2M communication" is used in order to describe the (technical) connection between an M2M device and a data center, between two devices or the like.

In a 2010 paper on convergent services, BEREC described 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.”*[4] In a recently published report by the EC, the following definition of IoT is used: *"The Internet of Things enables objects sharing information with other objects/members in the network, recognizing events and changes so to react autonomously in an appropriate manner. The IoT therefore builds on communication between things (machines, buildings, cars, animals, etc.) that leads to action and value creation".*[5]

Similarly, the GSMA only regards such automated exchange between machines as M2M communication where no human beings are involved.[6] However, according to other definitions, limited human intervention may be part of M2M communication.[7] In this case, services which can be remotely controlled, such as via smartphones or tablets, may also be examples of M2M services, e.g. remote control of air conditioning and heating systems or the remote (un)locking of cars. However, this does not imply a general statement on the qualification of a service as M2M service with regard to all cases where an app on a smartphone or tablet is involved.

For the purposes of this report, it is not necessary to determine in detail which definition is most appropriate. Fixing a definition of M2M communications or M2M services only makes a crucial difference if obligations explicitly depend on that distinction. In this regard, we note that the definition which includes “limited” human intervention is less clear-cut than the definition which excludes it, since it has to be determined on a case-by-case basis whether such intervention still is “limited”. However, also vague expressions can be interpreted by NRAs and the courts, but if one decided to apply such definition the merits of doing so should outweigh the legal uncertainty attached to it.

By contrast, other publications focus on the terms IoT and/or “Internet of Everything”[8] (IoE) when referring to the devices and services described in this report.The IoT describes the interconnection of large numbers of everyday devices to provide a range of new and innovative services.[9] Sometimes, the terms M2M and IoT are used to describe the same services and types of connections.[10]

Characteristics

Current M2M services broadly share some of the following characteristics:

- Fully automatic communication of data from remote devices (or with limited human intervention).
- Relatively simple devices, that can either be static (e.g. smart meters) or mobile (e.g. M2M devices integrated in connected cars).
- Low volume traffic, often with sporadic or irregular patterns. However, M2M applications have already emerged and/or might emerge in the future that transmit data in greater volumes, especially if demand for video-based services increases (e.g. automatic analysis of surveillance video streams, alarm systems).
- M2M services require connectivity, but connectivity accounts for a relatively low proportion of the overall revenue opportunity in the M2M value chain.[11]

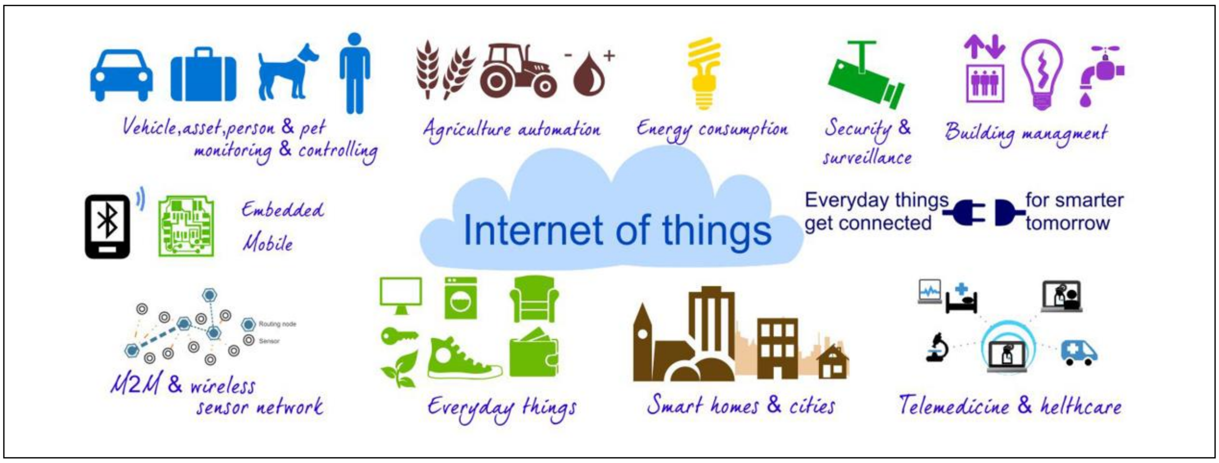
- Many M2M services are provided via devices designed and produced for the world market and for usage based on global mobility.
- Many M2M devices are designed to have a lifetime of many years and may be installed within equipment or infrastructure that itself has a long lifetime. Therefore, the cost of replacement may be relatively high.
- In most cases, the business model is B2B, even if devices may be aimed at consumers (B2B2C). The business model is usually not B2C.[12]

There are different ways in which M2M services could be implemented:

- Different connectivity technologies may be used and, in the case of wireless services, different spectrum bands may be used (cf. below in 2.1.).
- M2M services may use different protocols to deliver their data. They may be based on the IP protocol but could also use SMS, USSD and/or automatic calls.
- An M2M device is addressed via an identifier (e.g. number(s), IP-address), cf. below in 2.2.). However, not all M2M devices need global identifiers (e.g. those that are not connected to public networks).

Main areas of current and/or future applications for the IoT, including M2M communications, are: automotive[13], E-health services[14], smart metering/smart grids[15], smart home, smart cities[16], industry/automation and agriculture.[17] Examples are set out in figure 1 below.

Figure 1: Areas of application of M2M communications



Source: http://datasciencebe.com/. Image published under the article “The Thing in Internet of things”, published in https://inventrom.wordpress.com/

Typical examples of the M2M value chain

A market player may have several roles and there are many examples of how the M2M value chain may look. For the purpose of this report, the market players in the value chain are understood as follows:

Connectivity service provider
Provider of an electronic communication service pursuant to Art. 2 lit. c Framework Directive, i.e. basically a service normally provided for remuneration which consists wholly or mainly in the conveyance of signals on electronic communications networks.

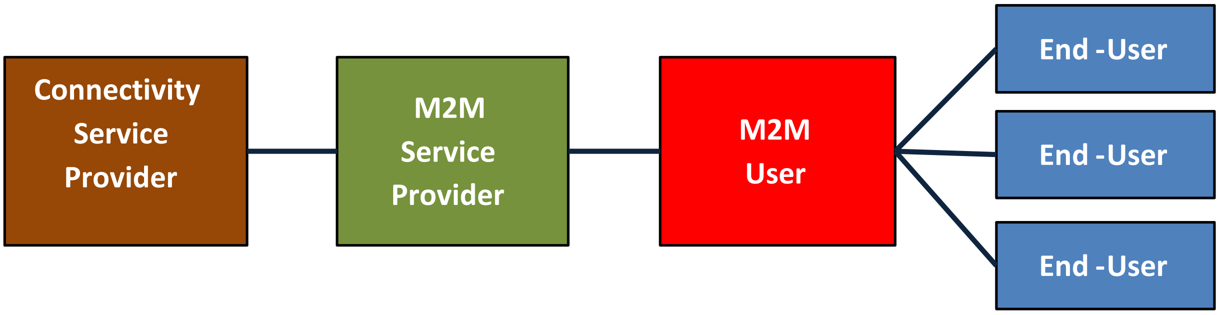
M2M service provider:
Provider of an M2M service, which can comprise the provision of an M2M platform and/or other M2M related IT-services/solutions.

M2M user:
Purchaser of an M2M service who incorporates the M2M service as one component in his own products (i.e. connected devices) and/or services (e.g. a car manufacturer, an electricity provider which also includes the provision of a smart meter in its service).

End-user:
Customer at the end of the value chain who purchases a connected device and/or utilises a service (including an M2M service and/or M2M device) (e.g. car owner, electricity customer). An end-user may be a private person or a company (e.g. private car owner and/or company with a car fleet).

One typical – and very simplified – example for an M2M value chain is shown in figure 2: For the sake of simplicity, not all market players are included in the chart.[18] In some cases, the same undertaking or subject may play more than one role at the same time.[19]

Figure 2: M2M value chain



Usually, the connectivity service providers' customers are the M2M device makers, the M2M service providers or the M2M users, not the end-users (in the sense of this report). Often the connectivity service providers have no relationship with the M2M service providers, and run their business with the hardware manufacturers. The end-user, on the other hand, buys an interconnected device and is not necessarily interested in the communication service as such. The service of the connectivity service provider to the M2M device maker, M2M service provider or M2M user is a wholesale-type of arrangement.

Industry	Connectivity Service Provider	M2M Service Provider	M2M user	End-user
Automotive	Connectivity Service Provider	M2M Service Provider	E.g. car manufacturers	Car / car fleet owner
E-Health			E.g. producers of medical equipment	Patient
Electricity			E.g. electricity companies	Electricity customer
Agriculture			E.g. producers of farming equipment	Farmer

For the M2M user, there are generally two main options to procure the connectivity service and the M2M service.[20] He can conclude one or two contracts. If he decides to conclude one contract, there are several sub-categories: In the above example, the M2M user purchases the M2M service from the M2M service provider who, in turn, purchases the connectivity from a connectivity service provider. The M2M user may also contract with the connectivity service provider which, in turn, purchases the M2M service as an input product. Alternatively the M2M user may choose to contract with a company which is an integrated connectivity service provider/M2M service provider.[21] Moreover, the M2M user may opt for concluding two separate contracts with the connectivity service provider and the M2M service provider. Apart from that, for an M2M service connectivity may be used which is provided according to a contract concluded between an end-user and a connectivity service provider. (i.e. where the M2M service is basically provided as an OTT service). In case of production and distribution of connected devices and/or services which include an M2M service or M2M device, the end-user is an entity separate from the M2M user. In case of industrial M2M applications, the M2M user usually is at the same time also the end-user. These described examples for M2M value chains are presented in Annex 1.

For M2M services to thrive several preconditions need to be fulfilled which relevant authorities (NRAs, European Commission, other authorities, Member States etc.) might help to establish and which are set out in the following sections of the report:

- Firstly, sufficient resources (like spectrum as well as numbers, IP addresses and other identifiers) in order to underpin and support the service (cf. section 2.).
- Secondly, an EU Telecommunications Framework which fits to M2M services (cf. section 3.).
- Thirdly, consumers’ acceptance of M2M services, which depends among other things on the information provided to them about the level of privacy, network and data security and interoperability of services, devices and platforms (cf. section IV. on privacy and standardisation as well as 3.4 on network security).

In the recent years, NRAs have primarily been contacted by stakeholders on issues regarding mobile network based M2M solutions. In addition, the 2014 interview sessions showed that participating stakeholders were mostly concerned with questions involving numbering, roaming and switching between service providers. Therefore this report assesses these topics in more detail. However, it has to be stressed that many M2M applications exist or may be developed which are based on another kind of connectivity (including fixed and another kind of wireless connectivity) than mobile connectivity.

In this report, several questions are addressed to stakeholders (cf. questions in the text on pages 11, 19, 23, 27 and 29 which are summarized in Annex 3).

2. Ensuring adequate resources for M2M services

M2M services will be underpinned by a number of fundamental resources, such as spectrum and telephone numbers or addresses. While technical management of the identifiers of the Internet (IP addresses) comes under the responsibilities of the Internet Corporation for Assigned Names and Numbers (ICANN), in co-operation with the Réseaux IP Européens Network Coordination Centre (RIPE NCC[22]), the allocation of spectrum and telephone numbers is within the remit of national authorities of the electronic communications sector, who will play an important role in ensuring an adequate supply of these resources to support the development of M2M services.

2.1. Spectrum

M2M services[23] may be deployed using a range of communication technologies, both wired and wireless. However, many of these services will require the flexibility or mobility of wireless networks and will, therefore, rely on the availability of spectrum to support their connectivity.

2.1.1. The different spectrum requirements for M2M

There is no one, single description of the spectrum requirements for M2M services; rather, the spectrum requirements for a given M2M service will be heavily influenced by the specific nature of that service. For example:

- From a technical perspective, lower frequency spectrum enables wider area coverage and better penetration deep into buildings;
- From an authorisation perspective, licensed spectrum – either for private/professional networks or for public mobile networks (terrestrial systems capable of providing ECS) – assures the reliable delivery of data, compared to unlicensed spectrum; and
- If there is a need for devices to have very long battery life, there may be a requirement to use bespoke and highly optimised technologies which may require their own allocation of spectrum to work efficiently.

More specifically, in many cases, the requirements of a particular M2M service will influence the technologies used to provide it, which, in turn, determine the underlying spectrum requirements. A range of existing and emerging technologies can be used to provide M2M services. They include:

- Personal and local area technologies: Short range connectivity can be provided by conventional, general purpose technologies such as Wi-Fi or Bluetooth. These technologies may be particularly appropriate for consumer M2M services, such as health or fitness trackers. Optimised versions of Bluetooth and Wi-Fi are also emerging;
- Wide area low power technologies: A number of bespoke technologies are being developed and are optimised specifically for certain M2M services. When deployed using sub-1GHz spectrum, these technologies are capable of providing relatively wide area coverage. In addition, their protocols enable them to use either licensed or licence exempt spectrum;

- Mobile technologies: Existing mobile networks, such as GSM, have been used for several years to provide wireless point of sale applications. Various technical enhancements are being proposed which will enable mobile networks to support a wider range of M2M services more efficiently and allowing connectivity service providers to support these services using much of their existing infrastructure. These enhancements include an air interface capable of efficiently supporting M2M services within a 200kHz channel bandwidth and M2M-optimised variants of the LTE standard used for 4G services. In the longer term, 5G networks will emerge that will efficiently support a range of services, including M2M; and
- Satellite technology[24].

2.1.2. Current availability of spectrum that can address the needs for M2M connectivity

The RSPG[25] Report on “Strategic Sectoral Spectrum Needs”[26] focused on the development of a strategic policy approach to meet spectrum needs for different sectors and in particular for the IoT, including radio frequency identification tags (RFIDs) and M2M. For this sector, the RSPG has identified no requirements that would motivate a harmonised European solution for dedicated spectrum for specific services or applications. However, the large predicted growth within some of these analysed sectors contributes to an increased need and demand for capacity and bandwidth, which may be met in the future through a suitably expanded identification of bands under general authorisations (exemption from individual licensing). Moreover, given their related key requirements, the RSPG considers that many of these needs are best to be realised using spectrum below 1 GHz.

The RSPG conclusion was motivated by the high availability of spectrum resources that can be used to address the different needs of different M2M services.

For M2M services using mobile technologies, any frequency band harmonised for terrestrial systems capable of providing electronic communications services can be used. These bands include the 800 MHz, 900 MHz, 1450 MHz, 1800 MHz, 2 GHz, 2.6 GHz and 3.4 – 3.8 GHz bands and in the future also the 700 MHz band.

Furthermore, many of the unlicensed frequency bands used by M2M services are harmonized by the latest update of Commission Decision 2006/771/EC for SRD (short-range devices) and by CEPT ERC Recommendation 70-03 (SRD). It is the case for Wi-Fi[27] and Bluetooth bands, and frequencies at 868 MHz used by M2M / Wide area low power. A regular update of this SRD Decision is anticipated in the SRD Decision, based on a permanent Mandate to CEPT as a regular review (next one is expected in 2016) based on the updates to ERC Recommendation 70-03.

Within Europe there are also many PMR/PAMR frequency bands in between 30.01 MHz and 942 MHz that could be used for M2M services.[28] These bands have a harmonization through ECC Decisions and ECC Recommendations which are voluntary for Member States to implement. The M2M usage in these bands is normally provided by bespoke networks optimised for a specific application and that do not need interoperability outside their own network.

Against this background the RSPG report also made the conclusion that future spectrum needs for M2M can be addressed via the ETSI-CEPT process.

The RSPG is further assessing the spectrum-related side of M2M in its current work on an “Opinion on the review of the current RSPP and its revision to address the next 5 years period”[29] and is going to deal with M2M under the frame of its next work programme.

2.1.3. Meeting future demand for spectrum

It is important that NRAs recognise that all delivery mechanisms of and technologies for M2M could be deployed by industry and other stakeholders as the M2M market develops. It is also important to acknowledge that the long lifetime and high replacement costs of many M2M devices could necessitate enduring access to certain spectrum bands over an extended period. NRAs should, therefore, seek to identify and remove possible barriers to the deployment of these technologies wherever feasible. For example, this could involve

- Modifying licence obligations to allow the deployment of M2M optimised technologies within their existing spectrum allocations;
- Modifying the usage conditions for specific bands for new use and users on a licensed or licence exempt basis;

Opening up bands for access on a shared basis.

An in-depth picture of the current situation of the spectrum usage in Europe[30] - not limited to M2M services - is provided by the CEPT via the ECO Frequency Information System (EFIS). This is the tool to fulfill EC Decision 2007/344/EC on the harmonised availability of information regarding spectrum use in Europe and the ECC Decision ECC/DEC/(01)03 on EFIS.[31]

In order to determine the likely future demand for spectrum for M2M services, it is necessary to form a view on the likely size and shape of the market. In Europe alone, a study prepared for the EU Commission recently expected IoT connections across EU 28 to exceed 6 billion units by 2020.[32] Given the significant number of likely devices, it will be important to ensure that there is sufficient spectrum to support the full range of M2M services. It is noted that Member States have developed different national solutions.[33]

Other current or emerging spectrum options for deploying M2M services include:

- *White spaces:* Applications could be deployed in the gaps between the transmissions of other systems, in spectrum that would otherwise remain unused. One example is the use of gaps between the transmission of digital terrestrial TV services below 1GHz; and
- *700MHz:* There is a proposal to use at national level the duplex gap and guard bands[34] of 700MHz which has been identified for future mobile broadband use.

In the longer term and as the market develops, the spectrum requirements for M2M services may change and it is therefore important for NRAs to monitor market developments and spectrum use and, if necessary, take steps to make additional spectrum bands available for M2M services. This could involve making new bands available, liberalising the use of existing bands or opening up bands for access on a shared basis.

A range of technology options are likely to be used to deploy M2M services. Given the variation in maturity in the evolution of the M2M market across Member States, NRAs should monitor market developments and spectrum use. For the benefit of harmonization, industry is invited to make use of the established processes via ETSI and CEPT if it identifies the demand for additional spectrum. Based on these harmonized European Standards and frequencies, NRAs are invited, where appropriate, to make spectrum available to support these applications.

2.2. Identifiers

Possible issues regarding scarcity of identfiers may only be applicable to public networks. Consequently, the analysis in this section is restricted to the following possible identifiers for M2M devices: telephone numbers (cf. 2.2.1) and IP addresses (cf. 2.2.2.). Other identifiers, such as MAC addresses or names – even if they are relevant for many M2M applications[35] – do not appear to have any significant limitation in their use if they are used outside public networks (e.g. “behind” an identifier which is the gateway to the public network). If low power wide area networks (LPWAN) technologies develop, specific issues with regard to identifiers might come up, in particular if it is a public network.[36] At this early stage of emergence of these technologies, this specific topic is not developed here.

2.2.1. Numbers

With regard to numbering, in the interviews carried out by BEREC in 2014, stakeholders pointed out the following issues:

- Type of numbers to be used for M2M services;
- Right to request numbers, in particular mobile network codes (MNC) for services using mobile networks;
- Scarcity of numbers;
- Extra-territorial use of numbers.

2.2.1.1. Type of numbers to be used for M2M services

The first issue relates to what kinds of identifiers are useful to identify M2M devices at the network level in a wide area network and how this might change in the future. The potential number of M2M devices is large and increasing. Accordingly, there will be a need for a large amount of device identifiers.

At network level in a wide area network, in general, the following national and international telephone number could be used for the addressing in M2M services:

- National E.164 numbers;
- International/global E.164 numbers (CC[37] 882/883) assigned by the ITU;
- National E.212 IMSI (International Mobile Subscriber Identity);
- International/global E.212 IMSI with MNCs under MCC[38] 901 assigned by the ITU.

At network level, no other public addresses seem to be used for the time being.

In particular, since the early stages of the development of M2M services, the approach by connectivity service providers and M2M service providers has been the use of existing ranges of national E.164 numbers (especially mobile numbers) and E.212. This is because of their relative ease of implementation into existing network infrastructures. 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 M2M devices, even after an increased use of IPv6 addresses.

Numbering issues related to M2M have been discussed (and are still being discussed) by CEPT ECC WG NaN. In this regard, reference is made in particular to ECC Report 153 on "Numbering and Addressing in Machine-to-Machine (M2M) Communications".[39]

In case of mobile subscriptions using public mobile networks, E.212 IMSIs and E.164 numbers are typically used.

2.2.1.2. Right to request numbers (in particular E.212 (MNC))

With the current national regulations, in various countries, the assignment of MNCs is limited to MNOs and, in some countries, to certain mobile virtual network operators (MVNOs). mainly due to an harmonization compromise within ITU-T (Recommendation ITU-T E.212). This means that many countries do not allow the assignment of MNCs to M2M users. Such an assignment might lower barriers to competition in the market if M2M users have the technical and economic capacities required to operate their own MNC (i.e. become assignee of an MNC) and to insource the respective activities in order to effectively switch from one connectivity service provider to another (see for the associated lock-in problem below in section 3.3.), which however might, at best, only concern the largest fleets of M2M devices.

As CEPT has pointed out, the presence of new market players for M2M suggests that NRAs should consider adopting greater flexibility in assigning MNCs. However, if new rules broaden the circle of possible assignees of MNCs, possibly including M2M users, the number of available MNCs in the resp ective country may decrease and lead to scarcity (see also 2.2.1.3. below).

Hence, each NRA should undertake measures to administer and allocate MNCs in a way that does not lead to scarcity.

Another solution to cope with the lock-in problem could be the promotion of SIM cards whose profiles can be uploaded and updated Over-The-Air (OTA), cf. also below in 3.3.2. Above all, this solution is likely to facilitate the change of connectivity service provider.

2.2.1.3. Scarcity of number resources

The availability of sufficient numbers (both E.164 and E.212) has to be ensured.

At present and under the current numbering plans, the possible scarcity of E.164 resources does not appear to be the main obstacle to the development of M2M. However, this potential issue should be carefully analysed and solved by each NRA at national level, if needed (e.g. by opening up a dedicated M2M numbering range or otherwise increase the resources dedicated to E.164 mobile numbers). Although, the introduction of new numbering ranges could introduce some difficulties and delay in their use.

With regard to E.212 resources, sufficient IMSIs (i.e. individual E.212 number resources) are available.[40] However, there is the risk of scarcity of E.212 resources (MNCs) due to the fact that, in most cases, only 100 MNCs are available per mobile country code (MCC).[41] In particular, scarcity could become an issue if the E.212 resource assignment rules are relaxed in order to take into account the presence of new players in the M2M market that could take advantage from having their own MNC. Possible solutions which try to reconcile the aim of promoting competition and preventing number scarcity are discussed in the ECC Report 212, “Evolution in the use of E.212 Mobile Network Codes”.[42]

2.2.1.4. Extra-territorial use of numbers

Based on feedback received from stakeholders, the majority appears to favour an extra-territorial use of national E.164 and E.212 numbers to support M2M services which are incorporated in products which are manufactured for the world-market. In many countries, it is currently unclear whether such an extra-territorial use of numbers is permissible in the M2M context. In any analysis of this issue it should be assured that public policy objectives (such as public security, national sovereignty etc.) are not compromised. An internationally harmonised approach could be desirable. In this context, reference is made to ECC Report 194 “Extra-Territorial Use of E.164 Numbers”.[43]

An alternative solution could be the use of global resources assigned by ITU (i.e. ITU-T Country Code 882/883 for E.164 numbers and MNCs under MCC 901 for E.212 ones). This could be useful in case of M2M services and connected devices that are distributed internationally but additional complications and costs may arise in the case of using global resources (e.g. conclusion of new roaming agreements, testing). Also, requesting ITU resources might prove a hurdle for some companies (in particular in view of the high membership fee). Promotion of the use of global resources might help to overcome these issues. It is noted that several MNOs and full MVNOs have already become assignees of an MNC under MCC 901.[44] Further assessment over time of the evolution of applications and services based on the use of such global ressources may prove useful.

A regional solution for Europe recently suggested by the European Commission might be the use of a European numbering scheme.[45]

[QUESTION TO STAKEHOLDERS: How do you evaluate the three options mentioned above (extra-territorial use of national E.164 and E.212 numbers, use of global ITU numbering resources, use of a European numbering scheme) for the provision of M2M services? Which of these solutions is preferable to address the need for global marketing of connected devices? Should these solutions be used complementarily?]

2.2.2. IP addresses

In addition to telephone numbers, IP addressing will be very important as an complementary addressing resource for M2M applications.

- Where devices are connected via fixed line or WLAN, IP addresses are used already today.
- If it becomes possible in public mobile networks to address devices directly via IP addresses, i.e. without the use of E.164 and E.212 numbers, also mobile M2M communication could be gradually converted and the use of numbers could be discontinued. However, at present it cannot be foreseen whether such fundamental changes will become reality.

The hitherto commonly used IPv4 address format supports a relatively limited number[46] of globally addressable devices; however, many connected devices may be located behind one IPv4 address using Network Address Translation (NAT). Given the expected growth of M2M services, and the number of Internet connected devices generally, this limited address space could quickly be exhausted.

The IPv6 standard has a significantly larger address space[47] and can support a considerably higher number of devices. Connectivity providershave recognised the importance of this migration for the growth of new services and are in the process of upgrading their networks to support IPv6. However, it is expected that IPv4 and IPv6 will exist alongside for quite some time although use of IPv6 has seen substantial growth over the last few years.

Within the EU, 66% of local internet registries (LIRs) have already taken steps[48] to support IPv6 and over 27% of networks[49] within the EU support IPv6. For a global M2M market, device manufacturers will consider the breadth of IPv6 deployment before beginning development of IPv6-only devices. This has the effect of the late movers in IPv6 deployment affecting the M2M manufacturers' decision process.

There might also be a substantial overlap period where both IPv6 – and IPv4 – addresses and E.164 numbers are in use. There are some estimations from stakeholders that it will take five to ten years for IPv6 to become widely available.[50] However, the issue of new E.164 numbers could begin to be phased out when IPv6 addresses becomes widely available and then only for those devices that do not have any requirement for traditional voice or SMS services. When mobility is a necessary characteristic of the service, E.212 resources probably will continue to be needed.

The Réseaux IP Européens Network Coordination Centre (RIPE NCC) is the Regional Internet Registry (RIR) for i.a. Europe. It is competent for the allocation and registration of Internet number resources. However, some Member States are competent with regard to some related aspects.[51]

The identifiers used for M2M applications in public networks are: E.164 (e.g. MSISDN) and E.212 (IMSI) numbers as well as IPv4 and IPv6 addresses. In the short and medium term – and perhaps even in the long term – classical telecommunications numbers (E.164 and E.212) will continue to be one solution to identify M2M entities. In the longer term, the use of IPv6 addresses might become the preferred solution.

Many of the numbering issues NRAs currently have to tackle – and which are primarily dealt by CEPT and/or ITU on an international level – concern M2M services based on mobile connectivity:

Firstly, 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 M2M. 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 M2M services or increasing the mobile number resources.

Secondly, the current national regulation in several countries does not allow M2M 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 SIM cards (cf. section 3.3.). 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.

Thirdly, the permissibility of the extra-territorial use of national E.164 and E.212 numbers and/or the actual possibility to develop M2M solutions based on global resources appear to be key for M2M services to be economically viable. Still, it must be ensured that public interests like security, national sovereignity etc. are not compromised.

With regard to IP addressing, the IPv4 addressing structure provides an insufficient number of publicly routable addresses to provide a distinct address to every Internet device or service (however, many connected devices may be located behind one IPv4 address), in particular in view of the expected growth of the market. Therefore migration to IPv6 appears to be advisable to enable the accessibility of connected devices from the public network.

3. M2M in the context of the EU Telecommunications Framework

Stakeholders have raised several questions on the applicability of certain obligations of the EU Telecommunications Framework to M2M services. This concerns above all obligations deriving from qualifying a service as electronic communication service (ECS) (cf. section 3.1.), obligations deriving from the Roaming Regulation (cf. section 3.2.) as well as a possible right to switch connectivity provider (cf. section 3.3.). NRAs can contribute to identifying and eliminating and/or reducing legal uncertainty and possible barriers to the development of M2M services in this regard. In addition, the rules concerning network security, which also apply to M2M communications, are relevant in the context of the EU Telecommunications Framework (cf. section 3.4.).

3.1. Applicability of the electronic communications regulatory framework

The applicability of the current regulatory framework depends on whether the respective service in the M2M value chain is qualified as an ECS according to Art. 2 lit. c Framework Directive.[52]

The definition of ECS and the applicable regulatory framework will be an important issue in the upcoming review process of the EU telecom rules. These issues will have an impact on a wide number of topics, e.g. M2M and Over-the-top (OTT) services.[53] In this light, assessing whether a given service in the M2M value chain is an ECS will have repercussions on other subjects, and vice-versa. Hence, a consistent approach is of the essence.

If a service is considered an ECS, the full-fledged regulatory set of rules applies including the notification obligation[54] as well as telco-specific rules on consumer protection[55], data protection[56] and network security.[57] Hence, it needs to be assessed as a first step if – and if so, at which level – an ECS has been identified in the M2M value chain.

According to Art. 2 lit. c Framework Directive, an ECS is *“a service normally provided for remuneration which consists **wholly or mainly** in the conveyance of signals on electronic communications networks, including telecommunications services and transmission services in networks used for broadcasting, but exclude services providing, or exercising editorial control over, content transmitted using electronic communications networks and services; it does not include information society services, as defined in Article 1 of Directive 98/34/EC, which do not consist wholly or mainly in the conveyance of signals on electronic communications networks”*.

According to this definition, there are three basic critiera for the finding of an ECS:

- Firstly, that the service normally is provided for remuneration.
- Secondly, that the service consists wholly or mainly in the conveyance of signals on electronic communications networks.[58]
- Thirdly, that the service consists in the transmission of content (and not in the production of content).

The analysis of the interpretation of these criteria is focused on the first two, the third being a “negative” one, that excludes services providing content but does not indicate which services are qualified as ECS.

3.1.1. Remuneration

The criterion “normally provided for remuneration” mirrors Article 57 of the Treaty of the Functioning of the European Union (hereinafter: TFEU) that establishes that services subject to the Treaty are the ones normally provided for remuneration. Due to the similarity of concepts the ECJ case law issued within the scope of Article 57 TFEU is relevant.[59] In this case law the concept remuneration has been interpreted by the ECJ in very broad terms and includes any benefit that constitutes consideration for the service. Connectivity services within the M2M value chain normally are provided for remuneration.

3.1.2. Conveyance of signals

The second element can be sub-divided in a two-step test, namely (i) whether signals on electronic communications are conveyed, and (ii) whether the service consists wholly or mainly in this conveyance of signals.

In this regard, it is of no relevance for the finding of an ECS whether the transmission of signals is by means of an infrastructure that does not belong to the respective service provider.[60] All that matters in that regard is that the service provider is responsible vis-à-vis the end-users for transmission of the signal which ensures that they are supplied with the service to which they have subscribed.[61] Hence, not only connectivity service providers with their own network infrastructure but also resellers – whose service wholly or mainly consists in reselling connectivity and who call on the service of, and systems belonging to, third parties – can provide an ECS.

The fact that various transmission technologies are used for M2M communication (cf. 2.1 above) does not affect the assessment whether the respective service represents an ECS or not.[62]

From the above, the following can be concluded with regard to services provided in the M2M value chain:

Services in the M2M value chain generally depend on a connectivity service as an input product but connectivity accounts for a relatively low proportion of the overall revenue opportunity in the M2M value chain.[63] Hence, in many cases it is decisive whether the respective service in the M2M value chain consists “wholly or mainly” in the conveyance of signals on electronic communication networks. This criterion leaves room for interpretation. Due to the variety of M2M services, this assessment may often only be possible on a case-by-case basis. This assessment may be made by an NRA, whose decision, however, may be subject to review by national courts and finally the ECJ.

It is helpful to assess the respective service (contract) in the value chain[64] in order to determine whether it can be qualified as an ECS.

Within the M2M value chain, the connectivity service provider who provides connectivity over a public network for renumeration[65] is generally a provider of an ECS.

With regard to the M2M user (e.g. car manufacturer, electricity provider), the following categories might be helpful.[66]

- Typically, an M2M user who includes connectivity as an input product into his products or services does not seem to provide an ECS when selling a connected device or “smart” service[67] (unless he wholly or mainly resells connectivity to his customers). In this case, the M2M user is similar to a producer and/or vendor of terminal equipment.
- Vice-versa, a reselling situation – and hence ECS – may be found at the level of the M2M user when the M2M user is contractually liable vis-à-vis the end-user for the provision of connectivity and this constitutes a whole or main part of what is sold.

However, since there are so many different types of packages including connectivity and since business models are just beginning to evolve, it has to be carefully assessed, also taking into account the spirit and purpose of the law, in which situations an M2M user may be qualified as a provider of an ECS.

To conclude, in those cases where market players are not regarded as providers of an ECS, they are not obliged under the respective national laws to notify their activities to NRAs of the countries where they are active. In those cases where these market players are providers of ECS, reference is made to BEREC’s general approach towards a possible relaxation of the notification obligation.[68] To date, with regard to the notification obligation no special treatment of an ECS contained in the M2M value chain appears necessary.

Within the ongoing review and DSM process the aim of fostering effective competition in the M2M industry for the benefit of the society and citizens should be considered. When doing so, it should be assessed whether and, if so, to what extent the existing rules which were primarily construed for voice telephony do also fit to M2M communications or not. Moreover, the regulatory costs (i.e. time, manpower, costs) connected to the adherence to telecommunication rules should be taken into account. In addition, one should be aware that qualifying M2M users as ECS providers might lead to a rise in the number of notifiable market players. It should be carefully examinated during the review whether this shall be the purpose of the regulatory framework. Finally, this should be balanced against possible benefits for end-users. In particular, protection stemming from such regulation might increase trust and, in turn, willingness to use M2M services.

At national level, stakeholders sought clarification from NRAs with regard to the applicable EU regulatory framework (e.g. notification regime) in the M2M value chain. This, in turn, mainly depends on the finding of an electronic communication service (ECS) according to Art. 2 lit. c Framework Directive.

Under the present regulatory framework, the connectivity service provider who provides connectivity over a public network for renumeration is generally the provider of an ECS in the M2M value chain; he is responsible vis-à-vis NRAs for the compliance with the obligations deriving from the EU regulatory framework. In contrast, the M2M user (e.g. car manufacturer, provider of energy including smart meter) typically does not seem to provide an ECS. According to such an approach,

M2M users would not be subject to the rules of the EU regulatory framework. However, there would be a finding of an ECS if the M2M user wholly or mainly resells connectivity to the end-user. Overall, since there are so many different types of packages including connectivity and since business models are just beginning to evolve, it has to be carefully assessed by NRAs in which situations an M2M user may – or may not be – be qualified as a provider of an ECS.

Within the ongoing review and DSM process it should be assessed whether and, if so, to what extent the existing rules which were primarily construed for voice telephony do also fit to M2M communications or not. Also possible regulatory costs and/or the possible number of notifiable market players should be taken into account and be balanced against possible benefits for end-users.

3.2. Roaming

Depending on the particular business model, the underlying connectivity service linked to M2M services, which is incorporated into M2M services as an input product, can be provided by mobile public communications networks. In such a case, the connectivity can be provided via international roaming or via domestic networks. Furthermore, according to the business models being developed, roaming can function on a permanent or a transitory basis. Examples of this fact can be found in some of the business models set out in the introduction, such as connected cars, agriculture measuring devices or smart meters that are distributed worldwide, or devices as e-readers which may cross borders.

The key issues regarding the regulatory situation of M2M services when based on mobile connectivity involving international roaming are in particular

- Whether these types of services are under the scope of the Roaming Regulation and, furthermore,
- Whether the Roaming Regulation applies when the connectivity is provided based on permanent roaming.

The whole section deals with roaming for the case of mobile public communication networks (2G/3G/4G) for which roaming massively occurs at present.

In case new technologies such as low power wide area networks develop, they will also become subject to roaming services between different network operators of the same technology. Such agreements are already incorporated between e.g. Sigfox network operators or Lora network operators. This is not covered here, but may in time require attention in order to ensure that appropriate conditions are met for such roaming services.

3.2.1. General applicability of the Roaming Regulation

The purpose of the Regulation (EU) No 531/2013 of the European Parliament and of the Council of 13 June 2012 on roaming on public mobile communication networks within the Union (hereinafter Roaming III Regulation)[69] as stated in Art. 1, is to introduce "*a common approach to ensuring that users of public mobile communications networks, when travelling within the Union, do not pay excessive prices for Union-wide roaming services in comparison with competitive national prices (….)*".

Under the Roaming Regulation "*Union-wide roaming*" means, in the context of data roaming services, *"the use of a mobile device by a roaming customer (….) to use packet switched data communications, while in a Member State other than that in which the network of the domestic* *provider is located (…)" (Art. 2 f). In addition, a "regulated data roaming service" is defined in the Regulation as a "a roaming service enabling the use of a packet switched data communications by a roaming customer by means of his mobile device while it is connected to a visited network"* (Art. 2 m).

According to these definitions, the Roaming III Regulation only applies to mobile connectivity-based applications or devices that are connected to a visited network, meaning a mobile communication network situated in a Member State other than that of the roaming customer's domestic provider (definition provided by Art. 2 e of the Regulation).

At the wholesale level roaming services are provided on the basis of private agreements.

The Roaming III Regulation, when applicable (cf. scenarios below), establishes two types of limits to the commercial terms that might be agreed:

a) A general roaming access right, meaning that mobile network operators shall meet all reasonable requests for wholesale roaming access.[70] The guarantee of this right applies to every mobile operator before the existence of any commercial agreement. However, this general right is not unlimited. Mobile network operators may refuse access (only) on the basis of objective criteria.[71]

b) Price caps which cannot be exceeded by private agreements. The Regulation establishes maximum wholesale and retail charges for data, voice or SMS traffic on roaming.[72]

In a first step, it is analyzed whether the commercial relationships established between mobile operators to provide M2M services are subject to those two limits.

Regarding the general applicability of the Roaming III Regulation to M2M services, neither Art. 1 of the Roaming III Regulation dealing with its scope nor the definitions laid down in Art. 2 of the Roaming Regulation explicitly refer to M2M services. However, as set out previously, a connectivity service is always underlying an M2M service. When that connectivity service consists of public mobile connectivity for a a roaming device, this service will fall within the scope of the roaming regulatory framework, regardless of the parties affected by the connectivity contractual obligations.

At present, it derives from Art. 15 (4) of the Roaming III Regulation[73] underpinned by some specific references included in the BEREC guidelines on Roaming Regulation[74] that the European roaming regulatory framework applies in general to the mobile connectivity in M2M services.

Therefore the main regulatory measures regarding roaming are generally considered applicable to the mobile connectivity service underlying M2M services, implying that any M2M provider/mobile operator benefits from the roaming access right as well as from the price caps. Mobile network operators on the other hand benefit from the right to refuse access requests on the basis of objective critera (cf. above).

3.2.2. Permanent roaming in the context of the Roaming Regulation

A number of M2M services relying on mobile connectivity are provided on the basis of permanent roaming for different reasons:

- When the connected device is sold outside the country of production but uses a SIM with an IMSI of the country of production (e.g. cars, e-readers).
- In order to achieve better coverage (e.g. for smart meters).[75]

The Roaming III Regulation is legally not clear with regard to permanent roaming in the M2M context, neither with regard to

(i) The admissibility of permanent roaming as such nor with regard to

(ii) The question whether the Roaming III Regulation applies to permanent roaming.

The Roaming III Regulation makes no explicit reference to permanent roaming (no statement to allow or exclude it). In this regard, it only refers to the terminology "*when travelling with in the Union*" (cf. Art. 1 (1) of the Roaming III Regulation[76]) as well as the definition of *"Union-wide romaing"* (cf. above). Hence, the question whether permanent roaming is within the scope of the Roaming Regulation, depends mainly on an interpretation of the notions "*travelling*" and *"mobile device"*.

In light of the currently applicable roaming regulatory framework, BEREC concludes that – especially in the light of the fast developing nature and diversity/solutions of M2M services/business models as well as different permanent roaming scenarios – that there might be M2M services using permanent roaming where the scope and application of the Roaming III Regulation is indeed questionable. Against this background a case-by-case evaluation and legal interpretation should be envisaged taking into consideration the specific (technical) details and parameters of the respective M2M service in light of the purpose of the Roaming III Regulation. Moreover, since the Roaming III Regulation is aimed at protecting end-users (i.e. mainly consumers), one might question whether it is in the spirit and the purpose of the Roaming Regulation to grant rights to parties to a B2B relationship (which is typical for the M2M context).

When applying such case-by-case analysis, the following typical M2M roaming scenarios can be distinguished:

Scenario 1: The connected mobile device is travelling periodically (e.g. a car on a leisure trip).

Scenario 2: The connected device is used most of the time on the basis of permanent roaming, but the object is moving across borders (e.g. a car which is sold abroad).

Scenario 3: The connected device is used on the basis of permanent roaming but is not travelling at all, often with a long period of usage. Furthermore it is questionable whether in this case the connected device (e.g. smart meter, sensors) can be called a mobile device at all, since it is not used in a mobile fashion.

In scenario 1, there is no permanent roaming and the Roaming III Regulation is applicable. In scenario 3, because the device is not travelling it is likely that the Roaming III Regulation does not apply. In scenario 2, it is less clear whether the Roaming III Regulation applies or not. However, it lies in the nature of a case-by-case approach that it does not provide safe harbours.

The approach above described may change in view of the Proposal of the European Parliament and of the Council, for amendments to the Roaming III Regulation[77], which in principle will be applicable as of 30 April 2016. According to the Proposal, the revised text of the Roaming III Regulation explicitly mentions permanent roaming. In particular, the reference offer (which roaming providers have to publish) may include conditions to prevent permanent roaming or anomalous or abusive use of wholesale roaming access for purposes other than provision of regulated roaming services to roaming providers' end-users while the latter are periodically travelling within the Union (cf. replaced Art. 3 (6) of the Roaming Regulation). Furthermore, roaming providers may apply a "fair use policy" to the consumption of the regulated retail roaming services provided at the applicable domestic retail price level, in order to prevent abusive or anomalous usage of regulated retail roaming services by roaming customers, such as use of such services by roaming customers in another Member State than that of his domestic provider for purposes other than periodic travel (cf. new Art. 6b of the Roaming Regulation).

From these provisions, the following conclusions can be drawn:

- Firstly, a clear distinction between, on the one hand, roaming during "periodic travel" and, on the other hand, "permanent roaming" is made.
- Secondly, according to the proposed amendments to the Roaming III Regulation for Art. 3, networks may include conditions to prevent permanent roaming or anomalous or abusive use of wholesale roaming access for purposes other than provision of regulated roaming services. In other words, this would imply that the wholesale access obligation for such services does not apply for permanent roaming scenarios, but this does not prevent that operators may offer permanent roaming services on a commercial basis.

However, it is noted that the provisions do not differentiate between person-to-person communications and M2M communications (i.e. they do not foresee any special treatment for M2M communications). Therefore, in order to ensure legal certainty to all players involved, further clarification in the Roaming Regulation and/or in a Commission Communication as to (i) the admissibility of permanent roaming in the M2M context as such and (ii) the application of the Roaming Regulation to permanent roaming in the M2M context might be helpful.

3.2.3. Current functioning of the market

Irrespective of the question of the applicability of the Roaming Regulation to permanent roaming in the M2M context, BEREC notes the following on the basis of the available data:

- Currently there do not appear to be any limitations or refusals to conclude roaming agreements with regard to M2M services.[78]
- Moreover, it is likely that M2M roaming charges are below the regulated price caps.[79]

However it is noted that there seem to be issues on certain national markets since the roaming operator could benefit from the addition of the coverage of all the visited networks: basing such an ability on access obligations from the roaming regulation, while visited networks in the absence of national roaming are often prevented from doing so themselves, might create competition distortions. The use of permanent roaming might in some instances reflect the absence of national roaming.

[QUESTION TO STAKEHOLDERS: How do you regard the market situation in the M2M sector with regard to permanent roaming and national roaming?]

3.2.4. Use of international/global E.212

Currently, some operators use MNCs under the shared MCC 901 to offer transnational services by way of permanent roaming. The use of this specific code which is not linked to any country permits to better identify and limit the service in the context of roaming access agreements. The visited network is able to better estimate the number of visited SIM permanently roaming on its network and their consumption.

3.2.5. Concerns for the future

Even if there seem to be no access and pricing issues related to M2M connectivity with regard to the Roaming III Regulation and apart from a need for further clarification with regard to permanent roaming in the M2M context, BEREC still sees some concerns in the future:

Firstly, the question whether the Roaming III Regulation – and hence the access right – does apply might be of relevance at a later point in time. It cannot yet be foreseen how the markets will develop – and operators will react – once the principle of *“Roam like at home”* (RLAH) is applied by mid 2017 after a revision of the wholesale regulation which will probably result in a further decrease of the regulated caps. Permanent roaming could be seen as a means to emulate a virtual operator access. While at present such possibilities remain limited by the fact that international roaming access remains generally significantly more expensive than local access, further decreases in wholesale caps will probably increase arbitrage incentives to use roaming access obligations as a substitute to commercial MVNO access. This will in turn probably trigger reactions by MNOs to prevent such arbitrages, through stricter roaming access policies. Hence, there is the risk that access issues will occur in the future. However, any conclusion regarding this matter would be premature and will need to be revised in light of the final new Roaming Regulation.

Secondly, any possible further revision and/or clarification of the Roaming Regulation should explicitly take into account the specific M2M context. The rationale for roaming underlying person-to-person communication relates to consumer protection arguments which do not apply to M2M communication. A number of M2M services are currently provided on the basis of permanent roaming.[80] Considering that M2M might develop into a truly single European market, BEREC notes that permanent roaming – while not being justifiable by consumer protection – might facilitiate the creation of such a market. Against this background, any possible right of operators to refuse permanent roaming or to provide it on the basis of economically unattractive conditions should be drafted carefully and consider the particularities of M2M communications.

Considering that the tensions about permanent roaming are susceptible to stem from a decrease of wholesale caps, it could be further assessed whether, in the context ot the wholesale market regulation review to be initiated by the Commission mid 2016, rather than taking permanent roaming out of the wholesale access obligation, an approach could be set up where permanent roaming would be made explicitly eligible to the wholesale access obligation, but would not benefit from the wholesale price control, or would only be subject to the certain wholesale cap levels still to be set. Given that the Roaming Regulation is a consumer protection instrument, one might even consider to regulate permanent roaming in the M2M context and a possible access right in a different regulatory set.

The M2M sector has evolved to be a transnational market of services where a significant part of the devices supporting those services are conceived for global mobility, not only under the basis of temporary mobility but to be marketed globally on a permanent roaming basis. In this context, the possibility and the economic terms under which such connections can be provided are fundamental for the development of the sector.

Whereas many M2M services are nowadays based on connectivity which makes use of permanent roaming, the Roaming III Regulation is unclear regarding (i) the admissibility of permanent roaming as such as well as (ii) its applicability of the Roaming III Regulation to these situations. Whether the Roaming III Regulation is applicable to permanent roaming in the M2M context, depends mainly on the elements “travelling in the Union” and “mobile device”. Against this background a case-by-case evaluation and legal interpretation should be envisaged taking into consideration the specific (technical) details and parameters of the respective M2M service in light of the purpose of the Roaming Regulation. However, any case-by-case approach carries legal uncertainty. In contrast, the Proposal of the European Parliament and of the Council concerning amendments to the Roaming III Regulation explicitly mentions permanent roaming; the new provisions suggest that operators may include conditions in the reference offers to prevent permanent roaming. However, it is noted that these provisions do not differentiate between person-to-person communications and M2M communications (i.e. they do not foresee any special treatment for M2M communications). Therefore, further clarification in the Roaming Regulation and/or in a Commission Communication as to (i) the admissibility of permanent roaming in the M2M context and (ii) the application of the Roaming Regulation to permanent roaming in the M2M context might be helpful.

With regard to M2M roaming agreements, BEREC notes that, on the basis of the available data, there are no issues such as refusal to conclude roaming agreements or tariffs exceeding the price caps under current regulation conditions. However, debates concerning obligation to grant or a right to refuse access might occur in the future if RLAH applies. Furthermore, on certain national markets there seem to be competition distortions stemming from the fact that the roaming operator could benefit from the coverage of all the visited networks, while visited networks in the absence of national roaming are often prevented from doing so themselves. The use of permanent roaming might in some instances reflect the absence of national roaming.

Any possible further revision and/or clarification of the Roaming Regulation should take into account the specific M2M context. Considering that M2M connectivity services might be a truly single European market, BEREC notes that permanent roaming is currently used for the provision of a number of M2M services and might facilitiate the creation of such a market. Apart from that, the rationale for permanent roaming differs in the case of, on the one hand, person-to-person communication and, on the other hand, M2M communication. In the context the review of the wholesale roaming market to be finalized by the Commission in mid-2016, it might be worthwhile to consider an access right for M2M permanent roaming (however subject to no wholesale cap control or certain wholesale cap levels). Given that the Roaming III Regulation is a consumer protection instrument, one might even consider to regulate permanent roaming in the M2M context in a different regulatory set.

3.3. Switching / lock-in issue

The potential solutions to the switching/lock-in problem which are presented in this section refer to M2M services which are provided on the basis of connectivity (via SIM) over public mobile networks only.

Even if number portability might not be an issue for M2M users and/or end-users who do not need to communicate, or even be aware of a possible phone number associated to their M2M devices, switching the connectivity service provider can be identified as an issue regarding the development of M2M services and the functioning of the market.

At present, switching connectivity service provider requires a hardware modification of the M2M device (such as the replacement of the connectivity module or, when possible, the replacement of the SIM card), but the cost of dispatching technicians for each M2M device might outweigh the expected gains of the switch, especially for extensive deployments of equipment. As a result, it could negatively impact the incentives for a M2M user to switch to another connectivity service provider.

If switching costs are the key feature for a competitive M2M environment, M2M users should carefully evaluate pro and cons of the offered connectivity technologies, taking into account the drawbacks related to possible lock-in due to proprietary solutions or spectrum licences (such as Low Power Wide Area Network, wired data network) because switching connectivity service provider may in many cases require switching the connectivity technology and replacing the related hardware.

From this point of view, cellular networks based on 3GPP standards (GSM, UMTS and LTE) may be able to meet M2M users' expectations in a near future as two main solutions have been investigated by the industry to solve this issue:

- MNC assignment to M2M users such as utility companies (gas, water, electricity), car makers (see also 2.2.1.2. above);
- OTA provisioning of SIM.

3.3.1. MNC assignment for M2M users

On the one hand, if M2M users become entitled to be assignees of MNCs, they could contract with connectivity service providers, like any MVNO with its own MNC, for the deployment of their services. M2M users would become Private Virtual Networks Operators (PVNO). Even if one assumed that assignment rules were modified by ITU-T according to a CEPT contribution proposal in order to allow national numbering plans to make available such assignments (which does not seem to happen quickly, if at all), this solution still raises questions regarding the technical and economic conditions required to operate its own MNC and effectively switch from one connectivity service provider to another:

- What infrastructure should the M2M user own by himself?
- What is the switching process? Has it already been tested under real conditions?
- What are the operational costs of switching connectivity service provider and the related risks on the security and the availability of the wireless connectivity provided to M2M devices as the M2M user might be responsible for operating highly sensitive core network equipement ?
- Will MNCs become scarcer if assigned to M2M users in greater numbers?

These issues must be addressed in order to understand whether MNC based switching solutions are more efficient than physically changing the connectivity modules, when possible, or using OTA technology and whether it can be applied for all M2M users or only the largest fleets of M2M devices. In the latter case, the issue still remains unsolved for a significant part of the M2M market.

3.3.2. OTA provisioning

The GSMA[81] has specified a mechanism for the remote provisioning and management of embedded SIM, allowing OTA provisioning of an initial connectivity service provider subscription, and the subsequent change of subscription from one connectivity service provider to another. This mechanism has been designed to answer M2M needs where SIM may not easily be changed manually.

For the moment, it seems that this mechanism has only been partially implemented for certain end-users (and mainly within closed co-operations among MNOs). At present, remotely programming the SIM appears to be technically feasible. However, no process has been agreed between MNOs which would enable an MNO to re-programme a SIM of a customer of another MNO (in case of a customer's wish to switch to another MNO) and which in addition provides for non-discriminatory access as well as a solution for security issues. This partial implementation of the GSMA mechanism is not fully effective for lowering switching costs. Connectivity service providers may be reluctant to go further as they fear losing control over the SIM in the event of OTA provisioning of a new profile.

However, this specification is quite recent (having been published by the GSMA in October 2014) and it is reasonable to expect that further implementation, including of switching features, may take place in the coming years. The fact that a sector-wide agreement on a global standard for switching through OTA provisioning could not be reached yet might prevent its development. However, a technical specification by ETSI is expected for Q2/2016.

Even if this solution appears promising, further assessment is required in order to prove if it can effectively lower switching costs and improve the flexibility of the M2M market in a non-discriminatory way. Apart from the already mentioned switching process description with cost and security analysis, this assessment might include at least checking the commercial availability of the product involved (SIM cards, OTA platforms).

Finally, if OTA provisioning does not enable switching between connectivity service providers within a reasonable time period, NRAs might consider adopting an obligation to introduce OTA provisioning at a certain point in time or at least regulatory mechanisms or incentives to foster OTA provisioning. Such an obligation might also encourage the sector to find an agreement on a global open standard for switching operator through OTA provisioning.

3.3.3. Evolution of the regulatory framework with regard to switching

As explained below, there is no mature solution to mitigate the lock-in problem related to switching between connectivity service providers of M2M services. However, we expect that at least one solution might be able to address this issue efficiently within the next few years.

[QUESTION TO STAKEHOLDERS: Which solution – OTA provisioning of SIM or MNC assignment to M2M users – do you think is preferable to facilitate switching between connectivity providers in the M2M sector? Which advantages, which disadvantages are attached to the two solutions?]

Depending on the switching solution (e.g. assignment of own MNC, OTA provisioning), without any regulatory incentive the biggest M2M users, such as the automotive industry, may have sufficient buying leverage on connectivity service providers to negotiate their business models. There is a possibility that smaller M2M users would not have access to efficient switching mechanisms.

An evolution of Art. 30 of the Universal Service Directive entitled “Facilitating change of provider” might be appropriate to grant M2M users the right to switch remotely between connectivity service providers, at least with regard to those connectivity service providers whose networks are interoperable with M2M user terminal equipment. In this context, it would also need to be assessed if number portability (cf. Art. 30 (1) of the Universal Service Directive) is required in the M2M context since the number of the connected device is typically not relevant and/or not known by the M2M user and/or the end-user of the device.

If a customer intends to change connectivity service provider, it is currently necessary that the SIM is replaced physically. The costs of doing so might prevent switching the connectivity service provider (lock-in). Over-the-air provisioning in order to switch connectivity service provider remotely is likely the key to mitigate the lock-in issue of the M2M value chain by dropping the cost of dispatching technician to upgrade M2M devices. NRAs could have good reasons to become active on this issue as connectivity service providers have little incentive to introduce it themselves.

A review of Art. 30 of the Universal Service Directive might be appropriate, both in view of facilitating a provider switch as well as with regard to the applicability of number portability in the M2M context

3.4. Network security

With the development and proliferation of M2M services, it becomes increasingly important to ensure secure and reliable communication among connected M2M devices. Different services will have different requirements for security and resilience. Many consumer services will not require a highly resilient network connection since temporary service interruptions will not significantly impact the integrity of the service provided. On the other hand, services that control important processes will require high levels of security and service availability. Such services could also be deployed over private networks, which do not fall under current legislation.

Traditional security approaches used in electronic communications may not be sufficient to address low cost devices used by many M2M services. Due to limited resources in terms of energy and computing power, such M2M devices may be vulnerable to cyber-attacks. An increasing number of less secure connected devices, which are exposed to a wider audience, can become a potential privacy and information security target that can have detrimental effects on consumer perception of security and acceptance of M2M services. In that regard, secure and lightweight protocols that can be used in such low resource environments will be required.

In order to mitigate network connectivity issues, Art. 13a of the Framework Directive (2002/21/EC as modified by 2009/140/EC) has already imposed certain security and integrity obligations on providers of publicly available networks and services, as follows:

- Networks and service providers must take appropriate measures to appropriately manage the risks posed to security of networks and services, in particular these measures shall ensure a level of security appropriate to the risk presented and to prevent and minimize the impact of security incidents on users and interconnected networks.
- Network providers must take all appropriate steps to guarantee the integrity of their networks and thus ensure continuity of supply of services provided over those networks.
- Networks and service providers must notify the competent NRA of a breach of security or loss of integrity which have a significant impact on the operation of networks or services.

NRAs which provided answers to BEREC confirmed that these obligations are in general implemented in their national legislation. The majority of NRAs also have powers to enforce these obligations.[82] National legislation of a Member State does not specifically address M2M services. All obligations apply also to M2M services provided that they are considered ECS or to the ECS which is underlying any M2M service.

[QUESTION TO STAKEHOLDERS: Do you think there is a need to adapt Art. 13a of the Framework Directive to address security concerns in the M2M context? If so, which adaptations do you consider to be useful?]

National legislation of a Member State concerning network security does not specifically address M2M services. All obligations apply also to M2M services provided that they are considered ECS or to the ECS which is underlying any M2M service.

4. Areas where NRAs can have a coordinating function

With regard to areas like privacy, data security and standardisation NRAs competences vary. Some have only limited or no competences at all.

However, NRAs could coordinate with the respective competent authorities, and with other stakeholders in industry, in order to create awareness and foster an innovation-friendly, as well as consumer-friendly, environment.

4.1. Privacy

One major issue to consider with regard to the IoT is the protection of privacy and personal data. ”Personal data” is defined in Art. 2 of the Privacy Directive (95/46/EC): ”*'personal data' shall mean any information relating to an identified or identifiable natural person ('data subject'); an identifiable person is one who can be identified, directly or indirectly, in particular by reference to an identification number or to one or more factors specific to his physical, physiological, mental, economic, cultural or social identity”*. Such private data may be collected in a number of services that are mentioned in Fig. 1 such as smart meters (which transmit data about consumption patterns), health applications (which transmit data about health conditions) etc. The fact that the data is transmitted via M2M communication does not change its qualification as personal data.[83]

The more connected devices there are, the greater amount of personal data will be processed (e.g. collected, stored, digitally analysed, shared) even by an unpredictable and non-controllable amount of people or organisations (e.g. producer of the device, platform administrators, technicians, provider of telecommunication services) and made available via the Internet. Whether it is consumer-driven processing of personal data or business-driven big data processing, the more applications and connected devices consumers and businesses are using, the greater the amount of information that needs to be managed and protected. In certain cases, the data holder may not even be aware that his data are collected.[84] Also, he might lose control over the dissemination of his data.[85] With such amount of personal data available, it would in principle also be possible to pool the information and to obtain a "profile" of a given person.[86] If this information is not protected, it can give rise to infringement of privacy.

There seems to be a general understanding among stakeholders involved in the development and implementation of M2M services[87], that the respect and protection of end-users' privacy is a critical success factor for the realisation of the prospects and growth of these services. If users do not trust that their data is being handled appropriately there is a risk that they might restrict or completely opt out of its use and sharing, which could impede the successful development of M2M.

With regard to personal data collected and shared in the context of M2M services, two different sets of rules may apply in EU Member States:

- The general relevant legal framework in the EU to assess privacy and data protection issues is composed of Directive 95/46/EC (Privacy Directive), which is currently under review[88];
- The specific provisions of Directive 2002/58/EC as amended by Directive 2009/136/EC (ePrivacy Directive) applies to the processing of personal data in connection with the provision of publicly available electronic communication services in public communication networks in the Community (cf. Art. 3 ePrivacy Directive).

These directives are transposed in national laws of the Member States aiming at protecting the privacy and integrity of end-users' data.

The jurisdiction and legal competence to enforce compliance with these provisions has been implemented in different ways among Member States. While the general rules of the Privacy Directive falls under the jurisdiction of the national data protection authorities, for the majority of NRAs the legal competence to enforce the provisions of the ePrivacy Directive is shared with the national data protection authorities or national ministries (generally following different related laws transposing the ePrivacy directive into national law).[89]

In contrast to the Privacy Directive (or rather the respective national law) the rules of the ePrivacy Directive are not only applicable to personal data of individuals, but provide for protection of the legitimate interests of subscribers who are legal persons, cf.Art. 1 (2).[90] The rules applies at least to the market player in the M2M value chain (cf. Fig. 2 and Annex 1) who provides the ECS underlying the M2M service in public communication networks, i.e. the connectivity service provider.

With regard to all other market players processing personal data, the Privacy Directive (or rather the respective national law) is applicable. In an opinion from September 2014[91], the Art. 29 WG tries to identify the role of the different stakeholders involved in the M2M value chain (such as device makers, IoT platform controllers) and to qualify their legal status as data controllers, and thus the national law applicable to the processing which they implement, as well as their respective responsibilities.

In the context of the provision of services in the IoT, all objects that are used to collect and further process the individual's data qualify as "equipment" in the meaning of Art. 4 (1) c) Privacy Directive[92] which is one possible requirement for the applicability of the Privacy Directive.[93]

The provisions in the ePrivacy Directive particularise and complement the Privacy Directive (cf. Art. 1 (2) ePrivacy Directive). Overall, the following rules contained in the two Directives are of particular interest in the IoT context:

- Purpose limitation[94];
- Information about data processing[95];
- Consent to data processing[96];
- Security measures[97];
- Notification obligation of the competent national authority in case of a personal data breach[98];
- Storing of information in terminal equipment[99];
- Processing of traffic and location data.[100]

However, there are no specific rules in these two directives with regard to M2M services as such, or to M2M communication. Until now, BEREC has not identified a need to deviate from the basic principles of data protection law in the M2M context, i.e. no need for a special treatment of M2M services has yet been considered. However, with regard to certain M2M applications it might be worthwile to consider rules which are more adapted to the M2M environment. For example the methods for giving information, offering a right to refuse or requesting consent could be evaluated in order to make them as user-friendly as possible.[101]

A step in the right direction might be the Council's General Approach of 15 June 2015[102] on the future General Data Protection Regulation which aims at strengthening individual rights of citizens and ensuring a high standard of protection adapted to the digital era. The reform foresees inter alia easier access to data, a right to data portability which shall make it easier to transfer personal data between service providers, more detailed information and more transparency (e.g. informing about a privacy policy in clear and plain language), a right to erasure of personal data and "to be forgotten" as well as limits to the use of "profiling". It is expected that the new rules will be adopted at the end of 2015.

In the same line, there are examples already today of how industry is working on solutions on how to comply with legal obligations and ensuring users' trust within the M2M context:

- Building privacy concepts into devices and services from the beginning. This so-called "privacy by design" approach requires an early and detailed consideration of a full range of privacy issues and how they relate to and interact with other components of the M2M ecosystem, such as network security, resilience and user interface design.
- Devising simpler terms and conditions for the collection and sharing of data, including the means to obtain informed consent from users via a range of innovative approaches.
- Related to simpler terms and conditions, many respondents supported the development of a common framework to simplify and categorise different levels of data sharing.[103]

[QUESTION TO STAKEHOLDERS: Do you think there is a need to adapt the Privacy Directive and ePrivacy Directive to address privacy concerns in the M2M context? If so,

which adaptions? Do you think that the reform of the Privacy Directive as foreseen in the Council's General Approach of 15 June 2015 on the future General Data Protection Regulation goes in the right direction?]

Personal data may be collected by a number of connected devices such as smart meters (which transmit data about consumption patterns), health applications (which transmit data about health conditions) etc. The fact that the data is transmitted and shared via M2M communication does not change its qualification as personal data.

The respect and protection of end-users' privacy is a critical success factor for the realisation of the prospects and growth of M2M services. If users do not trust that their data is being handled appropriately there is a risk that they might restrict or completely opt out of its use and sharing, which could impede the successful development of M2M.

While the general rules of the Privacy Directive (Directive 95/46/EC) are not sector-specific and apply in general, the rules of the ePrivacy Directive (Directive 2002/58/EC as amended by Directive 2009/136/EC) apply to the processing of data from both individuals and legal persons in connection with the provision of publicly available electronic communication services in public communication networks in the Community.

There are no specific rules in these two directives with regard to M2M services as such.

As to now, BEREC has not identified a need to deviate from the basic principles of data protection law in the M2M context, i.e. no need for a special treatment of M2M services. However, with regard to certain M2M services it might be worthwhile to consider rules which are adapted to the M2M environment. For example, rules on information and consent should be made as user-friendly as possible. A step in the right direction might be the Council's General Approach of 15 June 2015 on the future General Data Protection Regulation which is expected to lead to an adoption of the new rules at the end of 2015.

4.2. Standardisation

M2M devices need common, interoperable technical standards if regional or global markets are to yield significant economies of scale. Standardisation can intervene at different levels, such as the application[104] and connectivity layers. All along the service chain, a balance shall be struck between openness, interoperability, easiness, innovation and investment.

The potential trade-off between incentivising innovation by allowing proprietary solutions to be developed in a competitive process and increasing interoperability with the help of standardization processes is well-known.

In general, when a new application is introduced into the market, particularly if this application is as innovative as M2M-services, partnerships may have an important role as they help the service to spread out and to get regular improvements. Interviews conducted by BEREC in 2014 showed that many M2M applications were developed in a vertical way, with specialised and proprietary solutions, often created by partnerships of connectivity service providers, M2M users and M2M service providers (e.g. Global M2M Association, M2M World Alliance, Bridge M2M Alliance).

However, again according to these interviews, the proprietary solutions developed by the aforementioned partnerships and alliances often appear incompatible with each other. This situation may create switching barriers commonly referred to as the "lock-in" problem: the M2M user becomes dependent on a connectivity service provider (or a M2M service provider which is member of a specific alliance) for products and services, and he is unable to use another provider without substantial switching costs, due to the need to change apparatus, remote devices, etc.

Where such co-operation with regard to proprietary solutions violates competition rules (such as the prohibition of anti-competitive agreements and/or the abuse of a dominant position laid down in Art. 101 and 102 of the Treaty on the Functioning of the European Union and corresponding national laws) competition authorities would be competent to take appropriate measures. Otherwise, there is little scope for NRAs to intervene.

Still, the ease of switching between connectivity service providers as well as M2M service providers is important in order to create a competitive environment for M2M services.

For this reason, some stakeholders highlighted the necessity of standards to abolish switching barriers, solve the lock-in problem and help the future development of M2M services: in fact, the presence of standards could reduce the cost in realising M2M applications because research and development costs may be shared.

However, also co-operation with regard to standardisation has to respect competition law. In essence, where participation in standard-setting is unrestricted and the procedure for adopting the standard in question is transparent, standardisation agreements which contain no obligation to comply with the standard and provide access to the standard on fair, reasonable and non-discriminatory terms will normally not restrict competition.[105]

Among others, ITU-T has carried out standardisation initiatives related to the IoT under the Global Standards Initiative on IoT (IoT-GSI).[106] Its goal was to promote “a unified approach in ITU-T for development of technical standards (Recommendations) enabling the Internet of Things on a global scale”.[107] Such an initiative dates back to a report on the Internet of things from 2005.[108] ITU has in the meantime taken more concrete steps in a Recommendation ITU-T Y.2060 from June 2012.[109] The IoT-GSI concluded its activities in July 2015 and the new ITU-T Study Group 20 “IoT and its applications including smart cities and communities”[110] was established. All ongoing activities in the IoT-GSI were transferred to the new SG20.

As for standardisations bodies, since 2006, IETF (Internet Engineering Task Force) has also produced a series of standards and protocols designed for the IoT.[111] Besides, the initiative of ETSI focused on the development of an application-independent ‘horizontal’ service platform seems to be an important step.[112]

Besides, the “OneM2M” initiative was founded in 2012 by seven international standards bodies in order to set up “a common efficient, easily and widely available M2M Service Layer”.[113] To date, this initiative consists of 202 members (mainly from the industry), associate members (government and regulatory agencies) and partners (standards bodies). Although common standards in the application environment also play a significant role, the initiative’s objective is not, however, “to standardise the whole environment across networks, applications and devices [but the] interfaces so they are applicable to the entire ecosystem.”[114]

A recent study prepared for the European Commission stressed that “Current solutions and implementations tend to have a strong vertical market component, but in time broad-based, open horizontal platforms will emerge, especially if Europe will be able to insure open standards and widespread interoperability.”[115] It also pointed out that a “lack of standards and interoperability across fragmented European markets preventing economies of scale and scope." Therefore it came to the conclusion that "The EC should help developing the internal single market for IoT services and applications, by promoting the adoption of open standards and interoperable solutions across Europe, fostering the cooperation between standard bodies, pointing out relevant regulatory barriers and suggesting remedial actions."

In order to take appropriate actions, the competences of European Union institutions and NRAs over standardisation matters and their relations with CEPT, standardisation institutions and standard bodies' alliances shall firstly be identified. Then it shall be assessed whether the current situation is satisfying in regard of the objectives set out above. The activity of European Union institutions and NRAs regarding standards may go from mere vigilance to a more active role, by issuing recommendations for instance.

As regards the lock-in issue in particular, the potential impact of open or proprietary standards on the development of M2M services and the competitiveness of the market in general shall be further examined in full co-operation with stakeholders before taking any action.

[QUESTION TO STAKEHOLDERS: What is the impact of open and proprietary standards on the development of the M2M sector? What are the advantages and disadvantages of open and proprietary standards, taking in account that M2M services may be provided on private or public networks?]

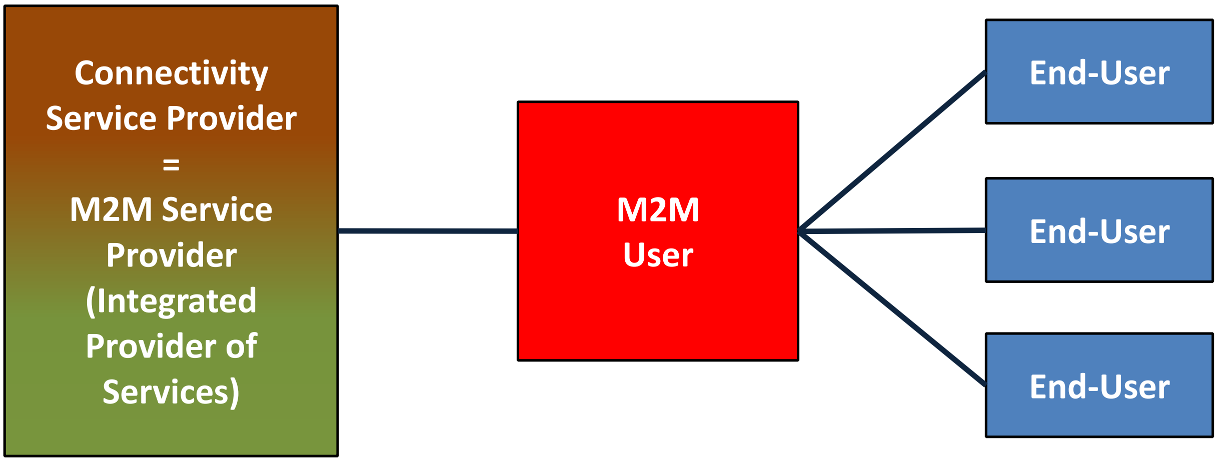
Standards play a significant role in the development of M2M technologies as they define openness, interoperability and ultimately competitiveness in the M2M environment. Standardisation bodies are already addressing the issue of standardisation in the M2M environment in a significant manner. The role of NRAs and European Union institutions over standardisation matters is to be defined in this respect but also in regard of their respective capacity to address standardisation issues respecting technological independence principle.

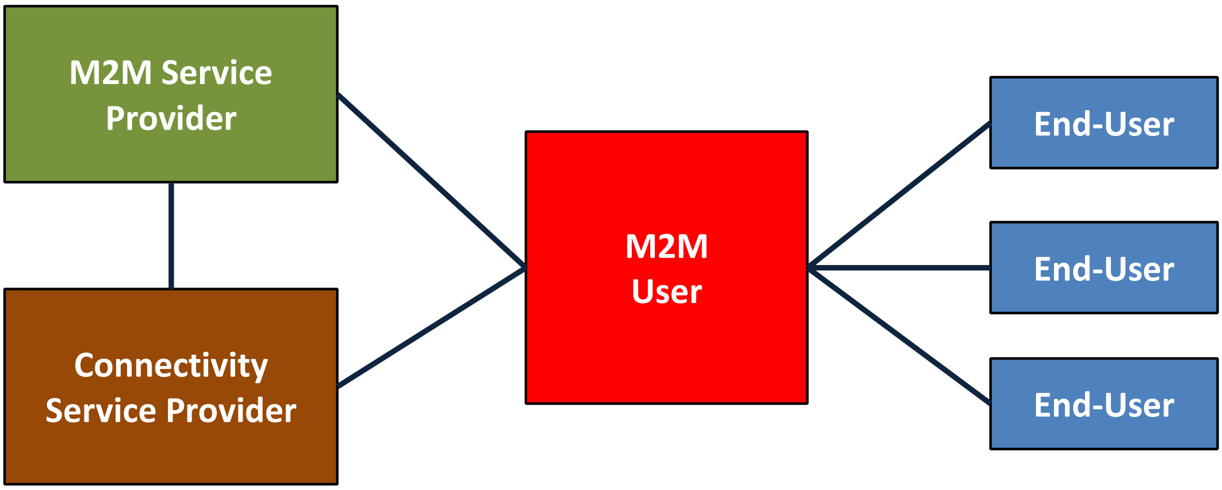
Glossary

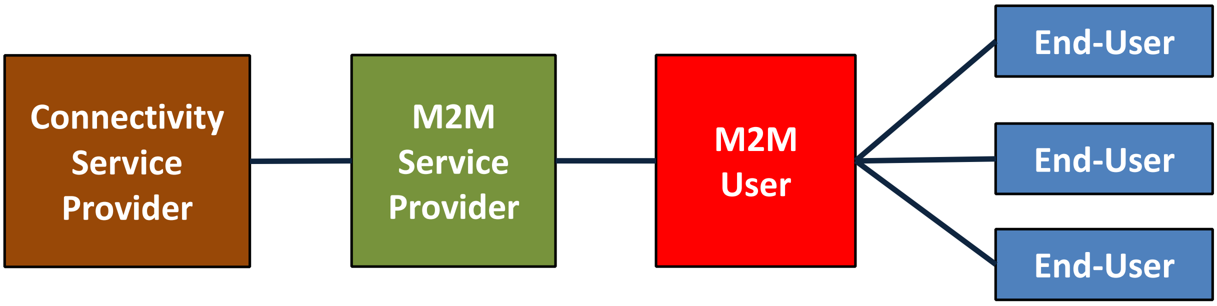
Connected device	Device/Product in which an M2M device is integrated (e.g. connected car, smart meter).
Connectivity service provider:	Provider of an electronic communication service pursuant to Art. 2 lit. c Framework Directive, i.e. basically a service normally provided for remuneration which consists wholly or mainly in the conveyance of signals on electronic communications networks […].
E.164 number	A string of decimal digits that satisfies the three characteristics of structure, number length and uniqueness specified in [ITU-T E.164]. The number contains the information necessary to route the call to the end user or to a point where a service is provided.
E.212 number	See IMSI, MCC, MNC and MSIN.
End-user:	Customer at the end of the value chain who purchases a connected device (including an M2M service and/or M2M device) (e.g. car owner, electricity customer). An end-user may be a private person or a company (e.g. private car owner and/or company with a car fleet).
IMSI	International mobile subscription identity: [ITU-T E.212] „IMSI is a string of decimal digits, up to a maximum length of 15 digits, which identifies a unique subscription. The IMSI consists of three fields: the mobile country code (MCC), the mobile network code (MNC), and the mobile subscription identification number (MSIN)“.
M2M service provider:	Provider of an M2M service, which can comprise the provision of an M2M platform and/or other M2M related IT-services/solutions.
M2M user:	Purchaser of an M2M service who incorporates the M2M service as one component in his own products and/or services (e.g. a car manufacturer, an electricity provider who also includes a smart meter in his services).
MCC	Mobile country code: [ITU-T E.212] The MCC is the first field of the IMSI and is three digits in length and identifies a country. The Director of TSB may assign more than one MCC to a country. MCCs in the 90x range are administered by the Director of TSB.
MNC	Mobile network code: [ITU-T E.212] The MNC is the second field of the IMSI, it is two or three digits in length and is administered by the respective national numbering plan administrator. The MNC, in combination with the MCC, provides sufficient information to identify the home network.
MSIN	Mobile subscription identification number (MSIN): [ITU-T E.212] The MSIN is the third field of the IMSI, it is up to 10 digits in length, and is administered by the relevant operator to identify individual subscriptions.

Annex 1: The M2M value chain – Examples

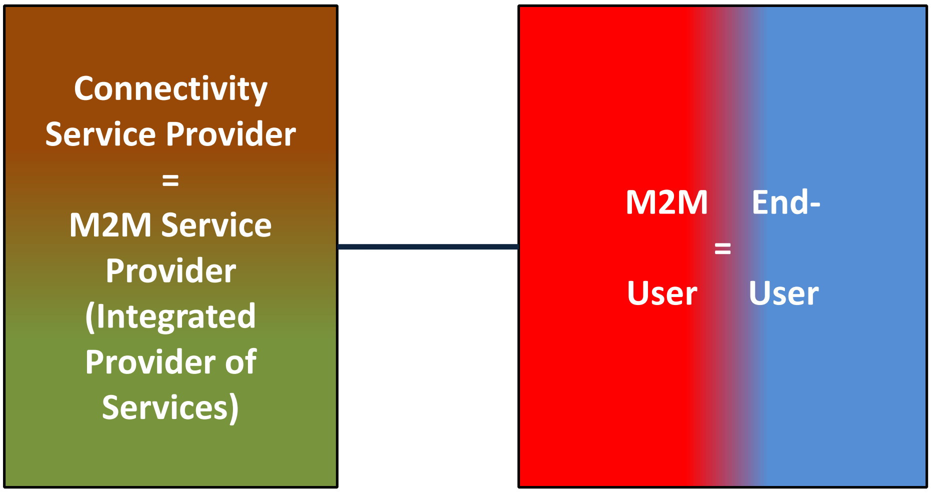
1. Business Applications


Connectivity Service Provider = M2M Service Provider (Integrated Provider of Services)
M2M User
End-User
End-User
End-User



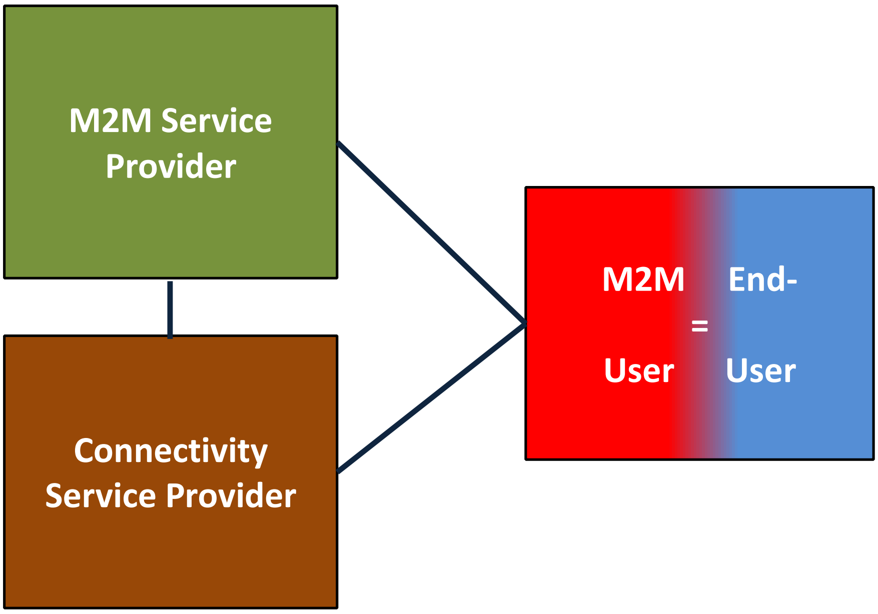


2. Industrial Applications



Connectivity Service Provider = M2M Service Provider (Integrated Provider of Services)

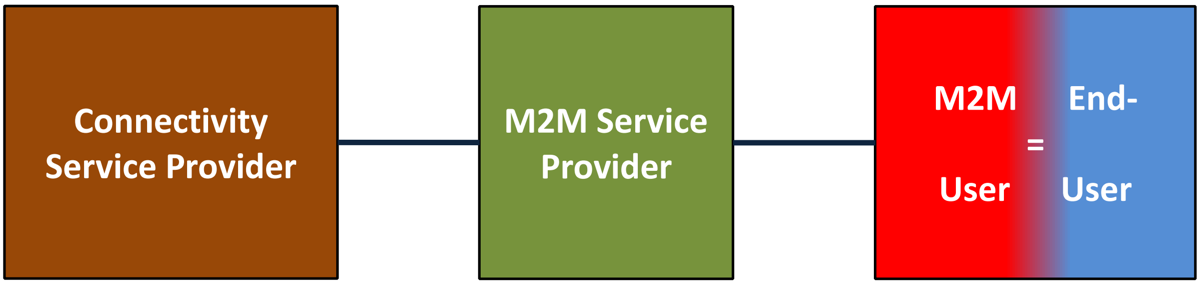
M2M User = End-User



M2M Service Provider

Connectivity Service Provider

M2M User = End-User



Connectivity Service Provider

M2M Service Provider

M2M User = End-User

Annex 2: List of BEREC M2M stakeholder interviews

Date	Stakeholder
16.06.2014	CISCO KCL
17.06.2014	ETNO GEMALTO ITU
26.06.2014	ECTA GSMA
27.06.2014	ETSI EURELECTRIC
17.07.2014	IET
18.07.2014	ERICSSON ETSI QUALCOMM
26.07.2014	Volkswagen
29.-30.09.2014	Aspider AT&T CoopVoce / Postemobile Fastweb Telecom Italia Tele 2 Sverige Vodafone Wind Telecomunicazioni

Annex 3: Questions to stakeholders

1. How do you evaluate the three options mentioned in section 2.2.1.4 (extra-territorial use of national E.164 and E.212 numbers, use of global ITU numbering resources, use of a European numbering scheme) for the provision of M2M services? Which of these solutions is preferable to address the need for global marketing of connected devices? Should these solutions be used complementarily?

2. How do you regard the market situation in the M2M sector with regard to permanent roaming and national roaming?

3. Which solution – OTA provisioning of SIM or MNC assignment to M2M users – do you think is preferable to facilitate switching between connectivity providers in the M2M sector? Which advantages, which disadvantages are attached to the two solutions?

4. Do you think there is a need to adapt Art. 13a of the Framework Directive to address security concerns in the M2M context? If so, which adaptations do you consider to be useful?

5. Do you think there is a need to adapt the Privacy Directive and ePrivacy Directive to address privacy concerns in the M2M context? If so, which adaptions? Do you think that the reform of the Privacy Directive as foreseen in the Council's General Approach of 15 June 2015 on the future General Data Protection Regulation goes in the right direction?

6. What is the impact of open and proprietary standards on the development of the M2M sector? What are the advantages and disadvantages of open and proprietary standards, taking in account that M2M services may be provided on private or public networks?

Endnotes

[1] ”Definition of a Research and Innovation Policy Leveraging Cloud Computing and IoT Combination”, Study prepared by IDC and TXT for the European Commission, 13 May 2015, cf. http://ec.europa.eu/digital-agenda/en/news/definition-research-and-innovation-policy-leveraging-cloud-computing-and-iot-combination, p. 26-27.
[2] Cf. Annex 2
[3] The ITU Radio Regulations contains the complete texts as adopted and revised by the World Radiocommunication Conference, cf. https://www.itu.int/pub/R-REG-RR and http://www.itu.int/dms_pub/itu-s/oth/02/02/S02020000244501PDFE.PDF.
[4] BEREC, Report on convergent services, BoR (10) 65, December 2010, p. 6.
[5] “Definition of a Research and Innovation Policy Leveraging Cloud Computing and IoT Combination”, Study prepared by IDC and TXT for the European Commission, 13 May 2015, cf. http://ec.europa.eu/digital-agenda/en/news/definition-research-and-innovation-policy-leveraging-cloud-computing-and-iot-combination.
[6] GSMA Intelligence, From concept to delivery: the M2M market today, p. 5: “The GSMA Intelligence M2M connections data used in this report refers exclusively to a SIM connection that enables mobile data transmission between machines. It does not count SIMs used in computing devices in consumer electronics such as smartphones, dongles, tablets, e-readers, routers and hotspots”. For a similar definition, see ETSI (ETSI TR 102 725 V1.1.1, Machine-to-Machine communications (M2M); Definitions): “physical telecommunication based interconnection for data exchange between two ETSI M2M compliant entities, like: device, gateways and network infrastructure”.
[7] ECC Report 153, Numbering and Addressing in Machine-to-Machine (M2M) Communications, November 2010, p. 5, section 1: *“M2M is a communication technology where data can be transferred in an automated way with little or no human interaction between devices and applications.”;* OECD, Machine-to-Machine Communications: Connecting billions of devices, DSTI/ICCP/CISP(2011)4/FINAL, 30 January 2012, p. 7. Moreover, this report does not make any statement on eCall services for which a special regulation applies, cf. regulation (EU) No 305/2013.
[8] This notion was first used by Cisco, cf. http://www.cisco.com/c/r/en/us/internet-of-everything-ioe/index.html and http://blogs.cisco.com/tag/internet-of-everything.
[9] Ofcom, Promoting investment and innovation in the Internet of Things, 27 January 2015, p. 9. See also ITU-T Y.2060, where IoT is described as *“[a] global infrastructure for the information society enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving, interoperable information and communication technologies”*.
[10] In fact the Art. 29 Data Protection Working Party describes IoT as *“an infrastructure in which billions of sensors embedded in common, everyday devices – “things” as such, or things linked to other objects or individuals – are designed to record, process, store and transfer data and, as they are associated with unique identifiers, interact with other devices or systems using networking capabilities.”* Cf. Opinion 8/2014 on the Recent Developments on the Internet of Things, p. 4.
[11] Source: GSMA report: Analysis – “From concept to delivery: the M2M market today“ February 2014, p. 12 (http://www.gsma.com/connectedliving/wp-content/uploads/2014/02/M2M-report_GSMAi.pdf).
[12] Hence, M2M services are changing the relationship between connectivity providers and end-users: the connectivity providers are losing the direct relationship with the end-user (typical B2C model), which becomes, instead, in many cases the prerogative of the “M2M user”.
[13] Smart cars: A wide range of car sensors can send automatic status updates to the manufacturer’s system to report on damages, making sure that garages are informed in time and the necessary replacement parts are in stock.
[14] Vital signs are recorded by smart wearable devices which inform – via an e-health gateway – connected parties, such as nursing services and doctors, if a patient forgot to take pills or even on life-threatening situations.
[15] Producers and consumers of energy (electricity, gas) are connected via M2M to ensure an optimised flow of energy without possible negative or positive peaks in consumption, which otherwise are likely to happen due to new forms of energy production (i.e. renewable energy).
[16] Public services such as lightning, waste management or the administration of parking areas can be offered at a lower cost rate when devices such as street lamps, garbage cans, parking lots, navigation systems and cars are connected to each other.
[17] Sensors for moisture or nutrients placed in the soil inform automatic watering and manuring devices to provide a growth process at the best possible rate.
[18] Not included are e.g. producers of hardware such as sensors and M2M devices.

[19] For example, a city planning to connect traffic lights might decide to supply itself with connectivity by building its own wireless network. In such a case the city plays all roles in the value chain.

[20] Apart from that, other options are possible. Moreover, the M2M user may opt not to procure the respective services but to provide them in-house (i.e. as a vertically integrated M2M user).

[21] Many of the connectivity service providers – especially if they are incumbents or other bigger players – appear to also offer M2M services, at least at group level.

[22] https://www.ripe.net/
RIPE NCC is the Regional Internet Registry for Europe, the Middle East and parts of Central Asia. They are in charge of the allocation and register of blocks of Internet number resources to Internet service providers (ISPs) and other organisations in the referred geographical service region. These Internet number resources are mainly in the form of IPv4 and IPv6 address space and Autonomous System Numbers (ASNs).

[23] Please note that the notion “service” is used throughout the entire document, including this chapter, to explain the service provided in the M2M value chain but not in the meaning of the definitions laid down in the ITU Radio Regulations. In the latter context, the notion “M2M application” would be more appropriate.

[24] Satellite technology is used in the logistics sector as well as in the aviation industry, e.g. the Aircraft Communications Addressing and Reporting System (ACARS), a system that automatically sends information by satellite from the airplane to the airline.

[25] Radio Spectrum Policy Group: High-level advisory group that assists and advises the European Commission on radio spectrum policy issues, on coordination of policy approaches, on the preparation of multiannual radio spectrum policy programmes and, where appropriate, on harmonised conditions with regard to the availability and efficient use of radio spectrum necessary for the establishment and functioning of the internal market. (Art. 2 Commission Decision of 26 July 2002 establishing a Radio Spectrum Policy Group amended by Commission Decision 2009/978/EU of 16 December 2009).

[26] http://www.cept.org/files/9421/RSPG13-540rev2_RSPG_Report_on_Sectoral_needs.pdf

[27] The 5 GHz Wi-Fi band is harmonised by the Commission Decision 2005/513/EC amended by 2007/90/EC and ECC Decision (04)08. The 2.4 GHz Wi-Fi band is harmonised by the SRD regulation.

[28] http://www.efis.dk/

[29] Adoption for public consultation expected for the RSPG plenary meeting in October 2015.

[30] For 48 European CEPT countries, including the EU Member States.

[31] http://www.efis.dk

[32] ”Definition of a Research and Innovation Policy Leveraging Cloud Computing and IoT Combination”, Study prepared by IDC and TXT for the European Commission, 13 May 2015, cf. http://ec.europa.eu/digital-agenda/en/news/definition-research-and-innovation-policy-leveraging-cloud-computing-and-iot-combination, p. 24

[33] Furthermore, by way of an example, a study for Ofcom in 2014 assessed the likely size of the M2M market in the UK for a range of applications and identified likely requirements for spectrum, cf. M2M Application Characteristics and their Implications for Spectrum, report for Ofcom, April 2014, http://stakeholders.ofcom.org.uk/market-data-research/other/technology-research/2014/M2MSpectrum. The study noted that the number of M2M devices is likely to be very large, growing to in excess of 360 million in the UK alone by 2022. However, given that many M2M services only transmit small amounts of data, the study concluded that, in the short to medium term, the UK’s existing allocations of spectrum would be sufficient to meet demand. In the UK, Ofcom has been proactive in identifying and making available spectrum bands that could be used for a range of services, including M2M. In particular, the 870-876MHz and 915-921MHz bands are available on a licence exempt basis and the 870-873MHz sub-band can also be used by higher power network relay points, which could be used to create meshed network architectures for M2M services. In France, ARCEP has launched, in 2014, a public consultation on the use of open spectrum aiming to deepen forward-planning on the future use of and need for open spectrum, particular in view of the upcoming development of the IoT. The feedback from market players served to underscore the importance and multiplicity of the issues that are bound up with the IoT. Frequencies, and particularly the identification of unlicensed spectrum, are key to the development of innovative applications. In the Netherlands, a frequency band previously allocated for personal mobile communications has been identified for M2M use. The frequencies around 450MHz will be used to support the country’s smart meter programme.

[34] The duplex gap is the portion of unused spectrum between the bands allocated for the uplink and downlink transmissions of a frequency division duplex (FDD) system. The duplex gap reduces the likelihood of uplink and downlink transmissions interfering with each other. The guard band is the portion of unused spectrum between two neighbouring allocations, typically used by different technologies, e.g. cellular and television systems. Leaving the guard band unused reduces the

likelihood of these different systems interfering with each other. Use of the duplex or guard bands could be possible under certain conditions, such as very low transmission power.

[35] Such identifiers may be used in M2M devices which are not - o not directly – connected to a network termination point, e.g. in private networks (e.g. M2M industry applications) or networks connected via a gateway to the public network (e.g. smart home applications), or meshed networks (e.g. car-2-car communication).

[36] LPWAN technologies are generally based on technology specific device identifiers. In case these networks develop, an efficient allocation process of these identifiers might have to be set up to answer the needs of operators and their customers, which may in time deserve some attention.

[37] Country Code (CC).

[38] Mobile Country Code (MCC).

[39] Published in November 2010; in the following: ECC Report 153.

[40] Under one MNC, 10 billion International Mobile Subscriber Identities (IMSI) are available (provided that the Mobile Subscriber Identification (MSIN) is 10-digit).

[41] Although the ITU-T Recommendation E.212 foresees the use of 2 or 3 digits for this field, actually in most countries only 2 digits are used.

[42] Published on 9 April 2014; in the following: “ECC Report 212”.

[43] Published on 25 April 2013; in the following: “ECC Report 194”. The ECC concludes that as a general rule the extra-territorial use of E.164 numbers should not be allowed because the negative effects listed in this Report outweigh the perceived benefits.
As a consequence:

- A country should in general refuse the assignment of E.164 numbers belonging to its numbering plan to be used outside of its territory on a permanent basis.
- A country should in general not allow the use of E.164 numbers belonging to another country’s numbering plan in its territory on a permanent basis.
- Extra-territorial use of numbers should only be permitted in exceptional cases which have been defined by an ECC Decision. Possible candidates are some nomadic voice services and some M2M services.

[44] A list over the current assignments of MNCs under the shared MCC 901 can be found at http://www.itu.int/net/ITU-T/inrdb/e212_901.aspx. Assignees include international MNOs such as AT&T, Vodafone, Deutsche Telekom, Telecom Italia, Orange and Telenor.

[45] Roberto Viola, “Machine to machine connectivity in a Digital Single Market”, published in the blog “Digital Agenda for Europe”, 04/09/2015, cf. http://ec.europa.eu/digital-agenda/en/blog/machine-machine-connectivity-digital-single-market.

[46] An IPv4 address consists of 32 Bit. Hence, 2^{32} (4,294,967,296) addresses are theoretically available, even if in practice a certain amount is reserved for other purposes than public network addresses.

[47] An IPv6 address consists of 128 Bit. Hence, 2^{128} (340,282,366,920,938,463,463,374,607,431,768, 211,456 ≈ $3{,}4*10^{38}$) addresses are theoretically available, even if in practice a certain amount is reserved for other purposes than public network addresses.

[48] RIPE Network Co-ordination Centre statistics as of 7 May 2015, defined as having a „ripeness“ rating greater than 0, http://ripeness.ripe.net/pies.html

[49] RIPE Network Co-ordination Centre statistics as of 7 May 2015, http://v6asns.ripe.net/v/6?s=_EU

[50] http://stakeholders.ofcom.org.uk/consultations/iot/?showResponses=true

[51] For example, in the UK Ofcom has a duty to report to the Government on the state of the telecommunications infrastructure and, in recent years, this has involved reporting on the state of IPv4 address availability and migration of networks to IPv6.

[52] Directive 2002/21/EC of the European Parliament and of the Council of 7 March 2002 on a common regulatory framework for electronic communications networks and services (Framework Directive), OJ L 108, 24.04.2002, p. 33, as amended by Directive 2009/140/EC, OJ L 337, 18.12.2009, p. 37, and Regulation 544/2009, OJ L 167, 29.6.2009, p. 12.

[53] The definition and scope of the so-called “OTTs” is currently a key issue in a separate BEREC working group.

[54] According to Art. 3 para 2 Authorisation Directive 2002/20/EC, amended by Directive 2009/140/EC, the provision of an ECS is only subject to a general authorization. The undertaking concerned may be required to submit a notification but may not be required to obtain an explicit decision or any other administrative act by the national regulatory authority before exercising the rights stemming from the authorisation.

[55] Cf. above all Art. 20, 21, 22 Universal Service Directive 2002/22/EC as amended by Directive 2009/136/EC.

[56] Directive on privacy and electronic communication 2002/58/EC as amended by Directive 2009/136/EC. Cf. in more detail below 4.1.
[57] Cf. Art. 13a of Framework Directive (2002/21/EC as modified by 2009/140/EC). Cf. in more detail below 3.4.
[58] ECJ, judgement of 7 November 2013, C-518/11, para. 38, 41 - *UPC Nederland*; judgement of 30 April 2014, C-475/12, para. 36 41- *UPC DTH*, which both concern broadcasting, namely the transmission of radio and television programmes.
[59] See, for instance, C- 263/86 - *Belgium v. Humbel*, C-180/98 - *Pavlov* or *C-206/98 - Commission v. Belgium.*
[60] C. f. Cf. ECJ, judgement of 30 April 2014, C-475/12 – *UPC DTH*, para. 43, 44.
[61] Cf. ECJ, judgement of 30 April 2014, C-475/12 – *UPC DTH*, para. 43.
[62] As is apparent from Art. 2 lit. a Framework Directive – which defines the notion of electronic communication networks – and Art. 2 lit. c Framework Directive, the fact that the conveyance of signals on electronics communications networks is effected by wire, radio, optical or other electromagnetic means, including satellite networks, fixed (circuit and packet-switched, including Internet) and mobile terrestrial networks, electricity cable systems (to the extent that they are used for the purpose of transmitting signals), networks used for radio and television broadcasting or cable television networks, is not decisive for the purpose of the interpretation of ECS, cf. along these lines ECJ, judgement of 30 April 2014, C-475/12 – *UPC DTH*, para. 41 with explicit mentioning of cable and satellite infrastructure.
[63] „*From concept to delivery: the M2M market today*“, February 2014. GSMA Intelligence.
[64] Cf. figure 2 in the introduction as well as in Annex 1.
[65] A different assessment might be possible, in particular if the connectivity is sold in-house (i.e. vertically integrated companies or public institutions) and/or via private networks.
[66] Please note that this guidance is not a statement of law and is without prejudice to the interpretation of the notion of ECS by the ECJ.
[67] This holds in particular true if the connectivity is a secondary or free element of the final product or service that could be considered as self-provision in order to provide an added value service, like, in the case of manufacturing cars, to monitor remotely the car.
[68] See for example BoR (14) 50, BEREC views on the European Parliament first reading legislative resolution on the European Commission’s proposal for a Connected Continent Regulation; BoR (13) 142 BEREC views on the proposal for a Regulation “laying down measures to complete the European single market for electronic communications and to achieve a Connected Continent” on a proposed single EU notification and authorisation.
[69] Regulation (EU) No 531/2012 of the European Parliament and of the Council of 13 June 2012 on roaming on public mobile communications networks within the Union; http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:172:0010:0035:EN:PDF
[70] Art. 3, para. 1, of the Roaming III Regulation.
[71] Art. 3, para. 2, of the Roaming III Regulation.
[72] Art. 7, 8, 9, 10, 12, 13 of the Roaming III Regulation
[73] *Paragraphs 2 and 3 shall not apply to machine-to-machine devices that use mobile data communication*“, which means M2M devices that use mobile data communication are excluded from the application of the obligations related to price information and cut-off limits imposed to retail data roaming services. This permits the reverse conclusion that the remaining provisions under that Regulation are in general applicable to M2M services (*argumentum e contrario*).
[74] Paragraph 66 of the “BEREC Guidelines on Roaming Regulation (excluding articles 3, 4 and 5 on wholesale access and separate sale of services)” indicates that “*Pursuant to Article 15(4) the transparency provisions do not apply to machine-to-machine devices that use mobile data communication*”; and, in addition, the executive summary, no. 8 of the same Guidelines also refers to M2M communication (“*Finally the BEREC guidelines cover various general issues such as charges for voicemail messages, charges in currencies other than the Euro, scope of regulated roaming call, scope of regulated data roaming, inadvertent roaming, value added services, machine-to-machine communication (M2M) and geographical scope of the Regulation*“).Guideline no. 8 of the “BEREC Guidelines on Roaming Regulation (Articles 4 and 5 on separate sale of roaming services)” establishes that “*There are no restrictions in the regulation, which exclude M2M services from the regulation, therefore decoupling does apply to these services based on public communications network as defined in Article 2(d) of the Framework Directive“.*
[75] In principle, this goal can also be achieved via national roaming. However, there is no regulated access right for national roaming and it is often not used in practice, while there is an wholesale access right for international roaming. The latter solution implies that the device is connected via the best network at prices below the caps. For the party requesting access, this saves transaction costs

and the need to negotiate access on the basis of national roaming. Overall, the need to achieve best possible coverage leads to arbitrage. In this case, permanent roaming in the context of M2M is very similar to the remailing scenario or to any situation of parallel import/trade.

[76] According to Art. 1 of the Roaming III Regulation, *"[t]his Regulation introduces a common approach to ensuring that users of public mobile communications networks, when travelling within the Union, do not pay excessive prices for Union-wide roaming services in comparison with competitive national prices, when making calls and receiving calls, when sending and receiving SMS messages and when using packet switched data communication services, (….)"*.

[77] Cf. 10409/1/15 REV 1; Interinstitutional File: 2013/0309 (COD) of 8 July 2015: Proposal for a Regulation of the European Parliament and of the Council laying down measures concerning the European single market for electronic communications and to achieve a Connected Continent, and amending Directives 2002/20/EC, 2002/21/EC and 2002/22/EC and Regulations (EC) No 1211/2009 and (EU) No 531/2012.

[78] In context of collecting data for the purpose of analyzing the impact of Rome Like at Home (RLAH), BEREC received replies from EU/EEA operators in 2014 which point in that direction: Either the operators responded that they lacked established procedures or lacked technical ability to detect and monitor the occurrence of permanent roaming on their networks, or respondents which dispose of such ability did not report any action in the sense of blocking these SIM.

[79] This is inter alia supported by the fact that average EEA wholesale data prices were below the price cap in Q2 and Q4/2014, cf. International Roaming BEREC Benchmark Data Report April-September 2014, http://berec.europa.eu/eng/document_register/subject_matter/berec/reports/4922-international-roaming-berec-benchmark-data-report-april-8211-september-2014. Moreover, according to information provided by some stakeholders, it appears that for M2M services the market has led to commercially negotiated wholesale roaming tariffs. According to GSMA, connectivity providers use specific MNC or MNC ranges for M2M traffic whereby M2M traffic can be identified among them. GSMA has referred to a specific Annex on Transparency where this is laid down which, however, has not been disclosed to BEREC.

[80] For the provision of many M2M services, the absence of permanent roaming possibilities would be a significant hassle, making impossible to use roaming aggregators and significantly increasing transaction costs.

[81] http://www.gsma.com/connectedliving/embedded-sim/

[82] Denmark, Italy and Spain have ministries which are directly responsible for their enforcement.

[83] Cf. similarly Opinion 8/2014 on the on Recent Developments on the Internet of Things, http://ec.europa.eu/justice/data-protection/article-29/documentation/opinion-recommendation/files/2014/wp223_en.pdf (in the following: "Art. 29 WG Opinion"), cf. chapter 3.2: *"In the context of the IoT, it is often the case that an individual can be identified based on data that originates from "things". Indeed, such data may allow discerning the life pattern of a specific individual or family […]"*.

[84] Art. 29 WG Opinion, cf. chapter 2.2.

[85] Art. 29 WG Opinion, cf. chapter 2.1.

[86] Art. 29 WG Opinion, cf. chapter 2.4.

[87] Sources: Ofcom consultation; Telenor Connextion; Gartner; Art 29.

[88] There is an ongoing review of the Privacy Directive (95/46/EC) and a new regulation has been proposed by the EC (cf. http://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:52012PC0011). Cf. for more information: http://ec.europa.eu/justice/newsroom/data-protection/news/120125_en.htm.

[89] This conclusion is based on responses to a questionaire carried by BEREC during 2015. In total 22 NRA responded to the three questions *(1) Does your national law place (based on EU law) any obligations on providers of electronic communication services and networks with regard to privacy?; (2) Does your NRA have any powers to enforce these obligations? If not, which authority is responsible for this?; and (3) Is M2M/IoT addressed in any way in these rules?*

[90] Eg. the rules on security (Art. 4) and confidentiality of the communications (Art 5) as well as the rules on traffic and location data (Art 6 and 9).

[91] Art. 29 WG Opinion, cf. chapter 3.3, chapter 6.2.

[92] Art. 29 WG Opinion, cf. chapter 3.1. This qualification obviously applies to the devices themselves (step-counters, sleep trackers, "connected" home devices like thermostats, smoke alarms, connected glasses or watches, etc.). It also applies to the users' terminal devices (e.g. smartphones or tablets).

[93] Art. 4 (1) Privacy Directive defines its scope of application, which inter alia is the case when the processing is personal data is carried out in the context of the activities of an establishment of the controller on the territory of the Member State (Art 4 (1) a) Privacy Directive) or when the controller is not established on Community territory and, for purposes of processing personal data makes use of equipment, automated or otherwise, situated on the territory of the said Member State, unless such

equipment is used only for purposes of transit through the territory of the Community (Art 4 (1) a) Privacy Directive).

[94] Art 6 (1) b) Privacy Directive which states that data can only be collected for specified, explicit and legitimate purposes.

[95] Art. 10, 11 Privacy Directive.

[96] Art 7 a) Privacy Directive.

[97] Art. 17 Privacy Directive; Art. 4 (1), (2) ePrivacy Directive.

[98] Art. 4 (3) ePrivacy Directive.

[99] Art. 5 (3) ePrivacy Directive.

[100] Art. 6, Art. 9 ePrivacy Directive.

[101] Cf. Art. 29 WG Opinion, cf. chapter 6.1 (p. 22).

[102] Council of the EU, Press release 450/15 of 15/06/2015, cf. http://www.consilium.europa.eu/en/press/press-releases/2015/06/15-jha-data-protection/; European Commission, MEMO/15/5170. Full text version: Council of the European Union, " Proposal for a Regulation of the European Parliament and of the Council on the protection of individuals with regard to the processing of personal data and on the free movement of such data (General Data Protection Regulation) - Preparation of a general approach" of 11 June 2015, 9565/15, Interinstitutional File: 2012/0011 (COD).

[103] Sources: Ofcom (page 14).

[104] See for instance, Zigbee Alliance, ZigBee Alliance and Thread Group Collaborate to Aid Development of Connected Home Products, zigbee.org, 2 April 2015.

[105] Cf. EU Commission, Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements, OJ 2001, C 11/1, para. 257 et seqq., in particular para 280.

[106] See the most recent constitution of a new group titled "ITU-T Study Group 20: IoT and its applications, including smart cities and communities". ITU, *ITU standards to integrate Internet of Things in Smart Cities*, Itu.int, 10 June 2015.

[107] ITU, *Internet of Things Global Standards Initiative*, itu.int, 2015 (http://www.itu.int/en/ITU-T/gsi/iot/Pages/default.aspx).

[108] ITU, ITU Internet reports 2005: Internet of Things, 2005. See Chapter 4 on "Emerging challenges" and more specifically Chapter 4.2 on "Standardization and Harmonization". An executive summary is available here: http://www.itu.int/dms_pub/itu-s/opb/pol/S-POL-IR.IT-2005-SUM-PDF-E.pdf

[109] ITU-T, *Overview of the Internet of things*, Y.2060, June 2012.

[110] http://www.itu.int/en/ITU-T/studygroups/2013-2016/20/Pages/default.aspx

[111] See Zhengguo Sheng *et al*., *A survey on the ietf protocol suite for the internet of things: standards, challenges, and opportunities*, Wireless Communications, IEEE, December 2013, vol. 20, issue 6.

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