**Doc. ECC(15)039 – Annex 13**

(Doc. FM(15)173 Annex 31)

**M2M Communications**

**Scope of the CG**

*Information on the regulatory framework for M2M communications spectrum on the basis of the bands already available for the various M2M usages. In principle, M2M communications could be realised in any mobile band, but also other radio applications may be suitable for some scenarios, e.g. Short Range Devices or even PMR.*

**Background**

ECC Report 153 “Numbering and Addressing on Machine-To-Machine (M2M) Communications - Luxembourg, November 2010” described Machine to Machine (M2M) as;

“*M2M communications are understood as a fully or largely automated communication (data transfer) between two or more information and communications (ICT) entities, that may be part of a predetermined group*”

In the ITU, ITU-T in Recommendation ITU-T Y.2060 (06/2012) has defined Internet of things (IoT) as “*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. Through the exploitation of identification, data capture, processing and communication capabilities, the IoT makes full use of things to offer services to all kinds of applications, whilst ensuring that security and privacy requirements are fulfilled*.”

ETSI has defined M2M Communications in ETSI TR 102 725 V1.1.1 (2013-06): as *Physical telecommunication based interconnection for data exchange between two ETSI M2M compliant entities, like: device, gateways and network infrastructure*.

Common key requirements for M2M applications today include:

• Often low power/low duty cycle (due to battery consumption constraints);

• Various radio access components are needed to address the demands of several sectors;

- Several applications require frequencies below 1 GHz due to propagation characteristics (e.g. penetration through building walls);

- Usage of commercial networks (responding to various needs);

• Moderate requirements on robustness and latency;

• Very high density in urban environments;

• Low per-device cost solutions;

• Often installed for a long period of time.

**Standardisation**

ETSI has published a number of related documents that give an initial overview of M2M

Requirements in ETSI TS 102 689

Functional architecture in ETSI TS 102 690

Interface descriptions in ETSI TS 102 921

It is understood that 3GPP are currently working on technical standards looking at bandwidths of 1.4 MHz and 3 MHz for “low-cost Machine-Type Communications (MTC) User Equipment (UEs) based on LTE Release 13. Release 13 is expected to be ‘frozen’ in 2016. 3GPP are also studying 200 KHz in GERAN.

General Overview

IoT (Internet of Things) or M2M (Machine to Machine communication) are general terms and correspond to a very complex ecosystem. M2M embraces applications and services on B2B (Business to Business), B2B2C (Business to Business to Consumer) or B2C (Business to Consumer) basis. From an applicative standpoint, M2M domain covers a wide gamut of vertical markets, including utility provisioning, transportation, healthcare, energy, retail, public safety, building and so many others. Part of them can be grouped under important classes like City Automation for instance, also called Smart City, some others are called connected objects, automotive, telematics or mobile healthcare, etc.

M2M requirements in terms of data security, resilience of networks, continuity of service, penetration and power consumption will vary significantly per application and devices. It will require different radio links and spectrum approaches, corresponding to those diverse operational requirements (uninterrupted vs. intermittent use; real time vs. delayed communication; command/control vs. collection of information; cloud based vs. network edge processing and storage), bandwidth usage (high vs. low data rates; high vs. low density), Quality of Service (security, resilience and robustness vs. best effort), coverage (wide area vs. short range; deep indoor vs. outdoor) and finally enabling ultralow power consumption and very high battery life (10 years plus for certain devices).

Widely interpreted M2M may contain ITS, RFID, IoT, Smart metering and Smart grids to some extent. Since most M2M applications existing today or foreseen can be carried over SRD, RLAN, PMR or MFCN (commercial mobile broadband networks), frequency bands can be made available for, but not limited to, M2M through licence exempt or designation for PMR or MFCN.

The predicted growth of M2M applications will put pressure on the use of existing frequency bands for SRD, especially below 1 GHz. Future designations for SRD, RLAN and PMR could ease that pressure. The need for a predictable sharing environment and also the need to find more efficient spectrum sharing solutions for some M2M applications has already led to investigations within CEPT on more sophisticated technology and application neutral spectrum access and mitigation techniques. Any evolutions of SRD, RLAN or PMR regulation should carefully consider results of sharing and compatibility studies.

**Regulatory Frameworks**

Primarily the principle approach to spectrum harmonisation in CEPT should be one that has the minimal level of regulatory intervention, so as to ensure that a predominately technology neutral approach can be respected. As is reflected in the background section, M2M does not define a particular access technology or technology per se, and does not define a particular spectrum band or bands or authorisation model. Equally M2M application will in many cases rely upon a wired network infrastructure exclusively, although some M2M set-ups may operate only on a wireless infrastructure. The next section details regulatory models available today that can be used to facilitate the deployment of M2M applications.

In complement to the traditional licensed approached, Licensed Shared Access (LSA) will play key role for enabling the IoE. LSA applies to underutilized spectrum that some users, especially government users such as the Ministry of Defence, do not use nationwide every hour of every day, but cannot vacate because they still need it from time to time or in specific locations or situations.

M2M Exemption Model

As a first note, many devices can already support a layer of M2M communications through a licenced exempt authorisation model where impact for interference is limited or negligible. Here, as general non limited examples, technologies such as Wi-Fi and Bluetooth can and do support M2M applications. These technologies are have also seen some development which could assist M2M services through a lower powered Bluetooth (Bluetooth Smart) and an optimised version of Wi-Fi, 802.11ah, which is being further developed. This is an indication that, for some M2M applications licence exempt spectrum can be used for M2M. CEPT are continuing to study other frequency bands, if which exempt, offers further opportunities for M2M applications. Where technologies are developed that are able to operate within the regulatory requirements at a CEPT level, which is predominately captured within Recommendation 70-03 (as amended), this offers one model of regulatory solution for M2M deployments.

ECC received from ETSI several ETSI system reference documents which fall under this category of the exemption model:

* Smart Meters and Smart Grids, TR 102 886
* Metropolitan Mesh Machine Networks (M3N) applications, TR 103 055
* Wideband SRDs with advanced spectrum sharing capability, TR 103 245
* DECT when operating in the 1900-1920 MHz band, TR 103 149

This has resulted in ECC in ECC Report 189 and ECC Report 200 as well as new entries in ERC Recommendation 70-03 Annexes 1&2 for the frequency ranges 870-876 MHz/915-921 MHz. For a possible DECT expansion band under generic regulation for license-exempt usage in 1900-1920 MHz, this is described in CEPT Report 52. There is also an on-going review in SRD/MG and SE PT24 with regard to wideband SRD applications such as 802.11ah.

A further option for M2M applications is the white space model. Here devices are likely to operate under an exemption model in a number of frequency bands.[[1]](#footnote-2)

M2M Licensed Regulatory Models

(1) PMR or PAMR

For M2M applications that require a range that is not satisfied via predominately low powered exempt spectrum use or require very reliable communications such as in smart grid networks, the potential to make use of PMR/PAMR also has potential for M2M applications. In CEPT European Common Allocation table lists numerous frequency bands from 30.01 MHz up to 942 MHz[[2]](#footnote-3) which could be used by M2M applications. Here PMR/PAMR applications generally permit higher powers thereby offering greater ranges than the exempt model. Also where data transmission is permit under local authorisation, this would allow for this type of regulatory model to offer another potential avenue for M2M usage.

One factor to consider is that, generally speaking, the overall bandwidths available will range from between 6.25 kHz and 50 kHz which would have a bearing on the type of access technology that can be used. This bandwidth would tend to relate data speeds lower than where wider bandwidths are used. However some M2M usage might well data rates at a lower level than general IP traffic. FM PT54 was already approached by smart grids proponents to use PMR/PAMR frequencies in the 400 MHz range. It is expected that ETSI is going to make available a new ETSI system reference document for spectrum demand in the order of 2x3 MHz (used by n narrowband/wideband channels in the 450-470 MHz band (the originating technical Committee in ETSI is TM4).

It is worth noting, however, that some CEPT administrations do permit the aggregation of the bandwidths quoted above[[3]](#footnote-4), thereby offering potentially higher data speeds. The use of the PMR/PAMR regulatory model networks would appear to be predominately bespoke M2M services that offer some mobility and have a variety of access methods, with some likely to be proprietary. There are however severe challenges concerning cross-border co-ordination needs which may need to be addressed for the 400 MHz frequency range with regard to the use of wider band air interfaces. The dominant use of the PMR/PAMR bands in the 400 MHz bands is based on narrowband applications up to 25 kHz channel bandwidth and according to a WGFM questionnaire in 2014, a total of around 120 000 narrowband individual PMR/PAMR licenses is currently awarded throughout the CEPT by the national authorities. There are big differences in the usage density amongst CEPT countries in these bands. In some metropolitan areas as well as border areas, some capacity shortage has already been observed.

Bespoke networks offer the potential for very efficient operation, as they have been designed to meet the specific requirements of the M2M application used (as opposed to the broader set of requirements for general consumer data services). As the spectrum under this model is generally licensed and assignments planned in some way, this might offer a higher QoS than the exempt approach.

Finally in some administrations the potential to use existing access technologies such as CDMA/GSM in the bands around 450-470 MHz in support of a M2M deployment is possible.

(2) Mobile networks - MFCN

Licensed spectrum in sub-GHz frequency ranges is required to deliver M2M services for the most demanding M2M application, in terms of QoS, coverage and battery life. Leveraging the potential benefits of the use of part of the harmonized 700MHz band at European level for M2M applications would respond to this requirement.

When wider mobility (or even permanent roaming) is required mobile operator MFCN networks, in a wide range of bands[[4]](#footnote-5), offer the potential for M2M applications. Use of MFCN networks, allow of high data rates and ubiquitous coverage and roaming., while ensuring QoS, security and resilience. This might suit applications such as smart metering, telematics, automotive and intelligent transport systems and mobile health and personal monitoring or consumer electronics. Again where M2M does not define a frequency band, the network defines the type of M2M applications that might benefit from the wireless infrastructure comparative selection in place.

The regulatory model almost always applied to MFCN frequency bands is a licensed model with authorisations normally for the whole geographical area of a CEPT administration. Presently the spread of access technologies used in MFCN networks vary between GSM, WCDMA and LTE, but again these allow for M2M applications to make use of MFCN networks with the appropriate interfaces between the device and the access technology. Two main technologies are now under consideration at 3GPP, for adoption as part of Release 13. On the one side, LTE MTC, (evolved Machine Type Communication) will address the requirements of many M2M applications. LTE MTC is part of the LTE-Advanced evolution and is planned to be part of 3GPP Release 13, expected to be completed by 2016. An important dimension of LTE MTC is that it allows the coexistence between M2M applications and adjacent mobile services in the same band, leading to considerable economies of scale. This is to be combined with enhanced security elements, extended coverage and up to ten years battery power. On the other side an enhancement to the technology used in 2G mobile networks (i.e. bandwidth of approximately 200 kHz) to support very low data rates while using the MFCN spectrum allocations as mobile networks (so-called GERANRelease 13); is also under development. In the longer term, 5G mobile networks may be designed to efficiently support a range of services, including M2M.

In this context, M2M can be deployed in any harmonised MFCN band, including 700 MHz, 800 MHz and 900 MHz. As recommended by the High Level Group Report lead by Pascal Lamy, one possibility is to take advantage of 2x3MHz in the 700 MHz band, for example in 733 – 736MHz and 788-791MHz. This would benefit from synergy with the considerable economies of scale driven by commercial mobile broadband LTE services to be deployed in the adjacent spectrum (703-733 MHz and 758-788 MHz). A 2x3 MHz in the 700 MHz band for M2M would respond to a number of key requirements for M2M. First of all, it would respond to the M2M need for one sub-GHz licensed band, without reducing the spectrum available for mobile broadband.

One of the key aspects of the 2x3 MHz is that it offers unmatched flexibility:

* It benefits from the reliability, QoS, security, pervasiveness, efficiency, longevity and economies of scale of MFC Networks and technologies,
* Infrastructure: the network could be deployed reusing the Mobile Broadband (MBB) infrastructure where possible, but could also be deployed independently where the roll out of a full 700 MHz MBB network is not justified,
* Terminals could be designed to support the full 700 MHz or just the 2x3 MHz, depending on the most desirable feature, but would in any case benefit from economies of scale linked to the 700 MHz band.
* Significantly increases battery life, while reducing cost/complexity and enhancing coverage

CEPT Report 53 and ECC Decision (15)01 consider Machine to Machine (M2M) as a national option in the 733-736 MHz and 788-791 MHz.

For the use of mobile networks - MFCN, for M2M applications where greater mobility or even permanent roaming is required, it is expected that the development of M2M applications will have an impact on national numbering plans because machines need to be uniquely identified and addressed in order to communicate with them, or rather to enable them to communicate with each other. The natural intention by operators and M2M Service Providers is to use E.164 numbers from the existing numbering plan for M2M services because of the relatively simple implementation in already existing network infrastructure and of the conclusion that IPv6 is not supported by the current networks.

The potential amount of M2M devices could be large and some applications may need several numbers (e.g. E.164 numbers) or addresses (e.g. IPv6 addresses), and therefore there is a potential need for a large amount of identifiers. It is recognised that some national numbering plans may not be prepared for such big demand for numbers. Thus a numbering strategy is required for both short and long term to meet requirements for M2M services. With ECC Recommendation (11)03 a harmonised view on preferable numbering solutions is given.

3) Other platforms

Point to Multi-Point systems

In some administrations Utility Operations have been using Resilient Machine to Machine (RM2M) systems for approximately 50 years. These are typically 9.6kbit/s, in 12.5 kHz, UHF Point-to-Multi-Point (PtMP) Supervisory Control and Data Acquisition (SCADA) systems. The systems are designed to, inter alia, reach remote / unpopulated areas and a link may therefore be 30km or more in length.

Point to Multi-Point systems may be available in other bands but their link lengths are likely to be much shorter.

Point to Point systems

In some administrations Utility Operations also use Resilient Machine to Machine (RM2M) Point-to-Point (PtP) systems. UHF is typically used for 9.6kbit/s, in 12.5 kHz, systems whereas 1.4 GHz and microwave bands may be used for higher data rates. Like the PtP links, the UHF links can be 30km or more in length.

ECC Report 215 (Assessment of the technical feasibility of introducing very narrow channel spacing in some existing plans, in guard bands and centre gaps of FWS channel arrangement at 6 GHz and 10 GHz) identifies additional, licensable, spectrum that may be suitable for low / medium data rate machine to machine systems.

It is quite likely that satellite platforms could also play a role in M2M applications, recognising that within the CEPT regulatory framework these could operate under either an exempt model or a licensed model in a variety of frequency bands available for satellite use.

**Conclusions**

There does not seem to be a strong case for the specific designation of specific frequency bands for M2M, since most M2M applications existing today or foreseen can be carried over SRD, RLAN, PMR or MFCN (commercial mobile broadband networks). Frequency bands can be made available for, but not limited to, M2M through licence exempt or designation for PMR/PAMR, Fixed Service, Satellite or MFCN.

Finally, it is therefore is illustrated that that M2M can be used in a number of frequency bands, using a number of services and radio applications, under both a licensing and exempt framework. This provides a number of options and that no single frequency band defines M2M (i.e. no single frequency band should be viewed in isolation) per se.

1. “Guidance for national implementation of a regulatory framework for TV WSD using geolocation databases” draft ECC Report 236 [↑](#footnote-ref-2)
2. Whilst PMR/PAMR services extend up to 942 MHz, it will vary between CEPT administrations as to the likely availability of particular frequency ranges. [↑](#footnote-ref-3)
3. Dependent upon local availability and technical feasibility. [↑](#footnote-ref-4)
4. 700MHz, 800MHz, 450 MHz 900MHz 1800MHz 2.1GHz, 2.6GHz 3.4-3.6/8GHz [↑](#footnote-ref-5)