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RADIO SPECTRUM POLICY GROUP

[Draft] Opinion for public consultation on

A Spectrum Roadmap for IoT

Draft Opinion on the Spectrum Aspects of the Internet-of-things (IoT) including M2M

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Background and scope of work

The RSPG's "Work Programme for 2016 and beyond"[1] identified a work item developing Europe's spectrum policy strategy regarding the Internet of Things[2] (IoT).

This draft Opinion has been prepared by a Working Group that has co-operated closely with Working Groups on Intelligent Transport Systems (ITS) and 5G. In developing the recommendations below, it has considered the current state of IoT; spectrum regulatory issues including access to spectrum and the availability of frequency bands; and the relationship between IoT and 5G.

RSPG Opinion on IoT

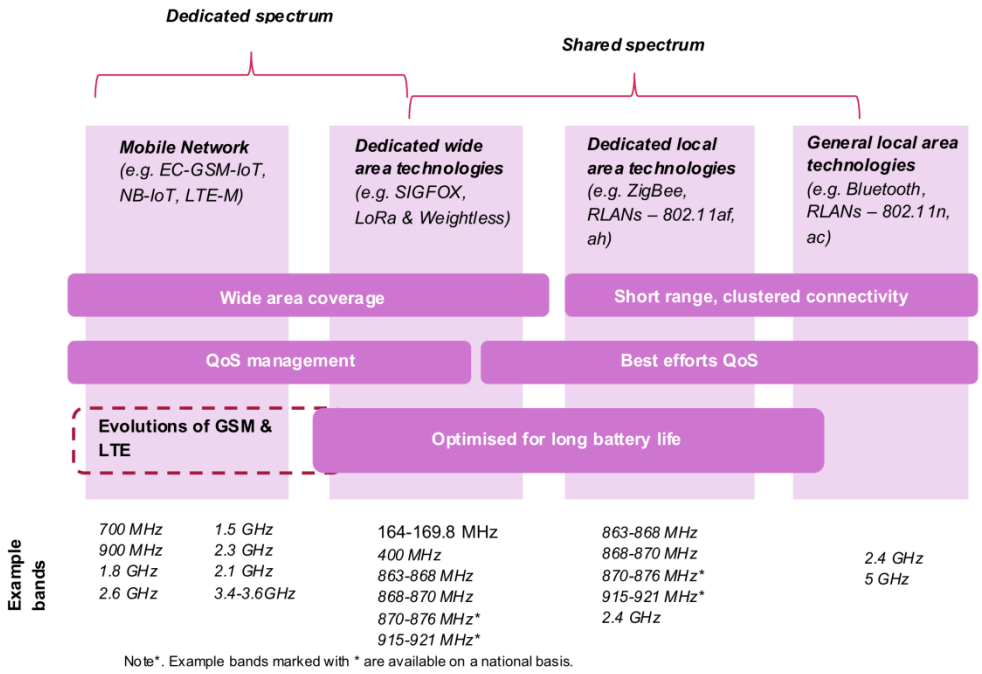
1. IoT is heterogeneous, encompassing multiple applications and operational requirements. There is no single solution for access to spectrum that fits all these possible use cases since their technical requirements differ dramatically, for example regarding data rate, reliability, range and output power.

2. Although the availability of frequencies is not currently constraining the growth of IoT, the continued growth of IoT applications creates an increased demand for access to spectrum. However, the quantity and type of spectrum access required will depend on the operational requirements and use cases. Therefore, there is work underway to make further spectrum bands accessible for IoT. For these reasons, the RSPG does not foresee a scarcity of spectrum for IoT, but will continue to review the evolution of spectrum demand for IoT.

3. Global economies of scale are important for emerging technologies, and Europe can benefit from these in three principle areas where spectrum is already widely available: bands for Short Range Devices, Mobile bands and those for WiFi (WAS/RLAN).

4. Collaboration by RSPG members can help realise further economies of scale in other bands. Further spectrum harmonisation and intervention is not needed for this – and may be counter-productive – but to guide its members, the RSPG proposes a roadmap for IoT spectrum access in Europe that reflects the various use cases and scenarios. Common focus on the bands in this roadmap could facilitate these further economies of scale, where currently they are only available on a national basis. This roadmap, and some of these bands are discussed further in the Annex.

[1] RSPG 16-007 Final of 24 February 2016.
[2] A broad definition of IoT is taken here, encompassing "M2M": see Annex.



5. A complementary mix of general and individual authorisation for spectrum access will be needed to ensure that IoT has access to spectrum. There is no single authorisation framework and no single set of technical conditions for access to spectrum, which would cater for all possible demands.

6. IoT encompasses a broader set of applications and use cases than those enabled by 5G. However, new IoT use cases will be enabled by 5G since some specific IoT functionality will be designed into 5G from the start, with features including network slicing, low energy consumption and scalability.

7. Frequencies allocated or identified for ECS (mobile networks) may be used for emerging IoT applications and services. Following the principle of technology neutrality, it should be ensured that the existing harmonised technical solutions fit with those for IoT. In this regard, the RSPG notes that the ECC is assessing whether the current technical conditions of ECS harmonised bands should be adapted to NB-IoT, LTE-based IoT and broadband IoT.

8. It is a separate challenge to make IoT stakeholders aware of their options for accessing spectrum, particularly since the heterogeneous nature of IoT means that stakeholders may not be familiar with spectrum management regimes, availability of frequencies and conditions of use. RSPG members will consider their frameworks for spectrum management from the IoT perspective, and seek to explain the opportunities for spectrum access for IoT.

Annex

1. Defining IoT

IoT refers to the interconnection via the Internet of computing devices embedded in everyday objects, enabling them to send and receive data.

Various publications have focused on the terms IoT and/or "Internet of Everything" (IoE) when referring to the devices and services. These publications describe IoT as the interconnection of large numbers of everyday devices to provide a range of new and innovative services. Machine-to-machine (M2M) is an older term used to refer to connected devices; sometimes, the terms M2M and IoT are used to describe the same services and types of connections. Fixing a definition of M2M communications or M2M services as distinct from IoT only makes a crucial difference if obligations explicitly depend on that distinction.

For the purposes of this overview and taking into account similar recent work in BEREC, it was not considered necessary to determine specific definitions for IoT and M2M. The intention is to take an inclusive view of connected devices and the spectrum they need.

2. A predicted growth of IoT applications

The IoT/M2M domain covers a wide range of vertical sectors, and within those there are use-cases both established and emerging.

Telemetry	Fleet management	Service and maintenance	Security and surveillance
• Utility meters • Parking meters • Industrial meters • Elevators • Vending machines	• Cargo tracking • Stock management • Temperature control • Route planning • Order tracking • Vehicle diagnostics	• Industrial machines • Vending machines	• Public surveillance • Asset monitoring • Congestion and movement monitoring • Urban management
Telematics and transport	**Home applications**	**E-health applications**	**Sales and payment**
• ITS • Navigation • Traffic / weather info • Road safety • Vehicle diagnostics • Location services	• Heating control • Electrical appliances • Alarms and security • Surveillance cameras • Garage and garden	• Patient monitoring • Remote diagnostics • Activity monitoring • Lifestyle suggestions • Personal security	• Point-of-sale terminals • Vending machines • Gaming and entertainment

This wide range of use cases translates to a range of operational requirements for IoT networks.

Massive communications	**Critical communications**
Use cases	
Collection/gathering of information Smart building Logistics, tracking and fleet management Smart meter Smart agriculture Capillary networks	Command/control/monitoring Remote health care Traffic safety and control Industrial application and control Remote manufacturing, training, surgery Industrial IoT, critical infrastructures (factory automation, motion control, remote control, smart grid, tactile internet, process automation)
Operational requirements	
Low device cost, simple cheap devices, low energy consumption Small data volumes, intermittent uses Can tolerate signal latency, no delay sensitive Massive number of devices Extended coverage (urban and rural	Ultra-reliability High availability Potentially uninterrupted communications Real-time communications, very low signal latency Guaranteed in-time delivery

environment), coverage inside of buildings	Often local coverage

3. Multiple frequency bands, opportunities for both general and individual authorisation models

Different authorisation models for access to the spectrum aim to meet various use cases and operational requirements, in particular in terms of (1) price of device, (2) time to market and (European, countrywide) network coverage, and (3) reliability and security. The frequency bands used for IoT include:

- Frequencies whose use does not need an individual authorisation but is subject to compliance with technical conditions defined in the framework of a general authorisation model.
  Such frequencies are used on a non-interference and un-protected basis. As a result, they are mainly identified for low power devices.

  Such frequencies are already used by IoT, including the following bands: 169 MHz, 433 MHz, 863-870 MHz, 2400 to 2483.5 MHz, 5150-5350 MHz and 5470-5725 MHz.

  Technologies such as Wi-Fi and Bluetooth may be particularly appropriate for consumer IoT services, such as health, fitness trackers, wearable or smart home devices, that do not have very high requirements for low latency communications and operate over a short range.
  Short range: Bluetooth low energy (Bluetooth smart); IEEE 802.11ah; IEEE 802.15.4; ZigBee; Z-Wave; etc.
  Long range (LPWA networks): Sigfox, Weightless, Ingenu, LoRaWAN, etc.

- Frequencies whose use is subject to individual authorisation, including:
  - frequencies allocated or identified for the implementation of public mobile networks (2G, 3G, 4G and 5G);
  - frequencies for the implementation of professional mobile radio networks (called PMR);
  - fixed service frequencies (wireless local loop, microwave);
  - frequencies of satellite services.

4. An expected increase in demand for spectrum in the medium and/or long term

For the foreseeable future there is no scarcity of spectrum for IoT. However, the predicted growth of IoT applications will create an increased demand for access to spectrum depending on the operational requirements and use cases. Moreover, the predicted growth of IoT applications could result in a proliferation of sectorial requests, for exclusive spectrum for specific allocations.

Taking into account the multiple applications, use cases and operational requirements, there is no “one size fits all” in terms of spectrum management for IoT. A consistent and global approach, conducted by Member States and the European Commission, will be essential in the event of a proliferation of sectorial requests.

It is important to ensure, in the long term, that access to the spectrum is not a barrier for the entry of new players in the IoT, noting that regulatory framework should not act directly on the technology but on the spectrum resources available for the development of IoT, considering the compatibility with existing services and their applications. With that objective, it is essential to focus now on the accessibility of appropriate frequency bands, their efficient management, the capacity of bands under both general and individual authorisation schemes, to cover all expected uses and not hinder the development of the IoT.

5. Spectrum resources under general authorisation model

Many IoT use-cases involve short-range uses and/or applications that can tolerate signal latency or delay. These can be supported through general authorisation model for access to the spectrum, because they are designed in such a way that they do not cause interference to other users nor they require protection against it.

Bands whose use is under general authorisation model do not seem to be a short-term hindrance to the deployment of IoT because the usable spectrum seems sufficient. However, a significant growth of new usages in those bands could, at some point, result in significant levels of interference and bring into question the sustainability of this situation. To avoid harmful interference, it is a key issue to define and maintain the appropriate level of technical conditions in the framework of a general authorisation model (without introducing un-justifiable conditions that, in particular, would hinder innovation), but when necessary, in particular in order to protect spectrum uses under the ITU status as primary service, to allow the use of frequencies for IoT applications under the individual authorisation regime.

Furthermore, monitoring is an instrument to obtain a detailed view regarding the use of spectrum resources under general authorisation model. Monitoring could be used to gather information on the overall usage of the spectrum and the expected growth of number of IoT devices. In particular, the band 863-870 MHz and the frequencies around 868 MHz appear to be very popular for all technologies currently deployed at scale; however, studies show that there seems to be sufficient spectrum.

It has to be noted that the use of such frequency bands under the general authorisation model is an appropriate environment for some players to test new technologies and services. This scheme reduces barriers to entry for all stakeholders, i.e. fair/equitable access to spectrum, no need for individual authorisation, no fees associated to the use of frequencies. General authorisation is a way to support experimentation and investment, to foster innovation, while at the same time promoting competition.

The work on managing the spectrum resource efficiently under the general authorisation model should take into account the following considerations:

- ensuring that authorisation mechanisms are technology neutral, as far as possible, and can support IoT and M2M in addition to other usages, in the targeted and adjacent bands;
- defining balanced solutions permitting all actors to operate with equal opportunity of access to spectrum (for instance, mixing low and high power applications or low and high duty cycle uses in a same band is not always desirable or possible);
- defining an authorisation arrangement that permits and accommodates various usages and technical requirements;
- ensuring market surveillance for SRD (key role of the duty cycle restrictions) and protection of systems in adjacent bands, especially since it is impossible to control the device density of users of spectrum under the general authorisation scheme.

a. <u>Opportunities to relax technical conditions for IoT in the band 862-868 MHz and to make available portions of the bands 870-876 MHz and 915-921 MHz</u>

In June 2016, the ECC approved for publication CEPT Report 59 in response to the European Commission permanent mandate on the “annual update of the technical annex of the Commission Decision on the technical harmonisation of radio spectrum for use by short range devices”. An Addendum to this Report, which will be ready for public consultation in November 2016, will address the possibilities for a harmonization approach for the bands 870-876 MHz and 915-921 MHz also taking into account new opportunities in the band 862-868 MHz.

Taking into account the free circulation and use of equipment within the Union for a number of Member States the protection needs of primary use of the spectrum still preclude the implementation of SRD in accordance with ERC/REC 70-03. These include the primary mobile services (government services and e.g. E-GSM-R) as well as governmental (military) usages which have to be protected. The draft Addendum has therefore made proposals that are intended to foster greater implementation by offering more focused regulatory solutions in the bands 870-876 MHz and 915-921 MHz, while giving administrations flexibility with regard to the precise implementation.

b. <u>Opportunities to open the band 1900-1920 MHz for IoT</u>

All or parts of the frequency band 1900-1920 MHz have been granted, through individual authorisations, to commercial mobile operators for the provision of ECS (authorisations mainly limited to UMTS/IMT-2000 TDD technology). However, this band remains largely unused. Moreover, a lack of interest of commercial mobile operators for spectrum in this band was demonstrated during the auctions in some European countries in 2011.

CEPT investigations led to the identification of these frequency bands for broadband direct air-to-ground communications (BDA2GC) as an alternative usage. The ECC Decision (15)02, of 3 July 2015, aims at harmonizing implementation measures for BDA2GC systems in this frequency band 1900-1920 MHz. Only two countries have indicated they have referenced this decision in their national table of frequency allocation. The European Commission decided not to develop a harmonisation measure for BDA2GC in the band 1900-1920 MHz and will assess the relevant impact of this decision in order to identify the best way forward for the future usage of this band.

DECT and SRD are both seeking to use spectrum. There is an opportunity to define, in a harmonised approach, technology neutral technical conditions for the use of the band 1900-1920 MHz that would allow for both DECT and SRD, in the framework of the general authorisation model.

6. Spectrum resources under individual authorisation model

Some IoT use cases involve applications that require ultra-reliability, real time communication, very low latency, very high availability, guaranteed in-time delivery. For such applications, the individual authorisation model for access to the spectrum can be appropriate to manage the quality of service, avoid uncontrollable delay (listen-before-talk) and interference.

Current examples include radio telemetry and telecontrol for national utility infrastructures (smart grid) and industrial processes (smart factory), and safety-related ITS.

Existing spectrum regulatory opportunities:

- frequencies allocated or identified for the implementation of public mobile networks (2G, 3G, 4G and 5G);
- frequencies for the implementation of professional mobile radio networks (PMR);
- fixed service frequencies (wireless local loop, microwave);
- frequencies of satellite services.

One potential benefit of an individual authorisation regulatory approach could be more acceptable sharing conditions with some other incumbent spectrum users as it could allow for better control of some critical sharing criteria such as deployment density.

a. Public mobile networks (2G, 3G, 4G and 5G)

There are about 1200 MHz of spectrum harmonised for ECS and a large part of this spectrum is used by 2G, 3G and 4G networks. RSPG concludes in its Opinion on "the implementation of the current RSPP and its revision to address the next period"[3], "*that the objectives of the first RSPP have been largely achieved. In particular the 1200 MHz target and the implementation of harmonised measures to support the internal market as requested by Article 6 are largely fulfilled*" (see annex 3 of this RSPG opinion, on "harmonised spectrum for electronic communications services (mobile broadband))".

The regulatory model, almost always applied to those frequency bands, corresponds to individual authorisations generally granted for the whole geographical area of a Member State.

Use of public mobile networks allows high data rates and ubiquitous coverage and roaming, while ensuring a managed level of quality of service, security and resilience. This might suit applications such as smart metering, telematics, automotive, intelligent transport systems, mobile health and personal monitoring or consumer electronics.

[3] RSPG 16-006 Final of 24 February 2016.

Although the existing M2M applications implementing through those networks are mainly relying on GPRS technologies, several new technologies are currently contemplated. Three technologies are being standardised in 3GPP for IoT:

- Extended coverage GSM for IoT (EC-GSM-IoT), enhancement to EGPRS for M2M, global cellular IoT for all GSM markets.
- LTE-eMTC, LTE evolution for massive MTC. LTE MTC is planned to be part of 3GPP Release 13, expected to be completed by 2016.
- Narrowband radio technology added to LTE platform for the provision of low-cost massive MTC (NB-IoT). NB-IoT is flexible and enables easy implementation, providing operational coverage and support for thousands of devices. Based on 200 kHz channel width, it can easily be inserted in GSM, UMTS or LTE bands.

RSPG notes that IoT functionality will be designed into 5G from the start, with features including network slicing, low energy consumption, and scalability. 3GPP's Release 15 “pre-5G” is aimed for June 2018, with Release 16 coming by the end of 2019.

Frequencies allocated or identified for the implementation of public mobile networks (2G, 3G and 4G), including the 700, 800, 900, 1800, 2100 and 2600 MHz bands, may be used for emerging M2M technologies. Taking into account the technology neutrality principle, it should be ensured that the existing harmonised technical solutions fit with these technologies. If necessary, Member States and the European Commission should be ready to adapt the current technical conditions of ECS harmonised bands for NB-IoT, LTE-M and EC-GSM-IoT.

For example:

- The recent 800 MHz authorisations are technology neutral, and do not refer to any radio technology in the technical conditions. It appears there are no regulatory barriers to deploying NB-IoT in the 800 MHz band (as long as all the technical conditions are met).
- The 900 MHz authorisations explicitly refer to GSM/UMTS/LTE/WiMAX, and require compliance with specific ETSI harmonised standards. Current versions of the ETSI standards do not cover NB-IoT. The current regulatory framework does not allow deployment of NB-IoT in the 900 MHz band.

b. <u>Professional mobile radio networks (PMR)</u>

PMR networks (from 30 MHz up to 942 MHz, including the 80 MHz, 150 MHz and 400 MHz bands) have provided solutions for M2M applications for many years.

Typical examples of M2M applications implementing through PMR networks:

- mission critical and safety related applications (transport, energy, etc.);
- applications with a long-range requirement that is not satisfied via spectrum resources under general authorisation model or that require very reliable communications such as in smart grid networks. Extra high voltage and high voltage smart grids will require enhanced communications and resilient systems (whereas the use of frequencies under general authorisation model would be appropriate for low voltage smart grid).

In particular, the 400 MHz bands are well positioned for critical connectivity for IoT and M2M, while ensuring the availability of frequencies for current and future PMR and PPDR usages and other legacy networks (radiolocation, governmental). They offer good propagation characteristics, cost effective coverage, better penetration deep into buildings and other types of premises where M2M devices are located. Challenges could be related to the introduction of new technology (e.g. NB-IoT) with different channel bandwidth (e.g. 200 kHz instead of 25 kHz) or to capacity shortage.

In addition to existing bands already used for PMR and the provision of solutions for IoT and M2M, Member States may identify alternative spectrum resources for PMR/IoT (for instance, the band 2,570-2,620 MHz could be considered).

If necessary, Member States and the European Commission should be ready to adapt the ECS regulatory framework to allow, at national level, to make available, for PMR/IoT, appropriate portions of existing ECS harmonised bands, according to market demand, with the objective to contribute to respond to national needs for the development of PMR/IoT (e.g. NB-IoT). This option should not call into question the global amount of 1200 MHz of spectrum harmonised for wireless broadband in Europe.

c. Fixed service frequencies

In some Member States, utility operations use resilient M2M point-to-point or point-to-multipoint systems. UHF is typically used for 9.6 kbit/s, in 12.5 kHz, systems. The UHF links can be 30 km 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 and medium data rate M2M systems.

d. Frequencies of satellite services

Satellite platforms could also play a role in the IoT / M2M applications, recognising that within the European regulatory framework these could operate in a variety of frequency bands available for satellite use.