arcep — autorité de régulation des communications électroniques et des postes

RÉPUBLIQUE FRANCAISE

# PUBLIC CONSULTATION

From 26 October 2018 to 19 December 2018

## Allocation of new frequencies for 5G

26 October 2018

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# Table of contents

## Practicalities of the public consultation

The opinions of all interested parties are being sought on the entirety of this document. To facilitate the feedback process, there are several questions pertaining to specific points on which input is being sought from certain stakeholders in particular.

This public consultation will run until 19 December 2018. Only those contributions received by that date will be taken into account.

Contributions must be sent to Arcep, preferably by e-mail – with the subject line, *Response to the public consultation "New frequencies for 5G"* – to the following address: CP5G@arcep.fr

Otherwise, they may be sent by post to:

> Réponse à la consultation publique « Attributions de nouvelles fréquences pour la 5G »
> à l'attention de
> Direction mobile et innovation
> Autorité de régulation des communications électroniques et des postes
> 14 rue Gerty Archimède
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In the interests of transparency, Arcep will publish all of the responses it has received, with the exception of any information that is protected by business confidentiality. Contributors whose response contain confidential elements are invited to provide two versions of their contribution:

- A confidential version, in which passages that may be covered by business confidentiality are contained in square brackets and highlighted in grey, e.g.: "a market share of [BC: 25]%";
- A public version in which passages that may be covered by business confidentiality have been replaced by [BC:...], for instance: "a market share of [BC:...]%".

Contributors are asked to keep confidential information to a minimum. **Arcep reserves the right to declassify certain information outright if, by its very nature, it is not protected by business confidentiality.**

Additional information can be obtained by sending your questions to: CP5G@arcep.fr.

This document is available for download on the Arcep website: www.arcep.fr.

# Introduction

Today's radio networks are poised to undergo a dramatic change with the introduction of 5$^{th}$ generation (5G) mobile technologies that will make it possible to meet the ever growing expectations of consumer and business users wanting to have access to powerful and reliable, ultra high speed, and low latency mobile services.

The European Commission launched an action plan[1] in 2016 whose purpose was to define a common timetable for launching the first 5G networks across the EU. The aim is to free up and allocate so-called "pioneer" frequencies for 5G (700 MHz, 3.5 GHz and 26 GHz)[2] to be able to roll out 5G commercial services in every country in the European Union before the end of 2020. In 2017, the EU's Estonian Presidency proposed a roadmap for 5G[3], co-signed by all of the Member States' Ministers responsible for electronic communications.

Moreover, the proposed Directive from the European Parliament and Council establishing the European electronic communications code (COM/2016/0590 final – 2016/0288 (COD)) – referred to hereafter as "the proposed European code" – specifies that Member States will take all of the necessary measures to ensure the allocation of sufficiently large blocks of spectrum in the 3.5 GHz band and, provided market demand is confirmed and no significant obstacle exists to releasing the frequencies, of at least 1 GHz in the 26 GHz band in each Member State, by December 2020.

All of the bands used by mobile network technologies will eventually be employed by 5G, notably the 1.4 GHz band which has not yet been allocated in Metropolitan France for public mobile network rollouts.

On 16 July 2018, the Government and Arcep published a 5G roadmap[4] which is line with the European timetable, and maps out a national ambition to bolster competitiveness and innovation in a range of economic sectors, thanks to the introduction of 5G. The roadmap's key targets include a 5G commercial rollout in at least one major city by 2020, and to have all of the major transport corridors covered by 5G by 2025.

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[1] "5G for Europe: an action plan"
https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016DC0588&from=EN

[2] For the purposes of this document:

- the 700 MHz band corresponds to the 703 – 733 MHz and 758 – 788 MHz frequency band duplex;
- the 1.4 GHz band corresponds to the 1427 – 1518 MHz frequency band;
- the 2.6 GHz band TDD corresponds to the 2570 – 2620 MHz frequency band;
- the 3.5 GHz band corresponds to the 3.4 – 3.8 GHz frequency band;
- the 26 GHz band corresponds to the 24.25 – 27.5 GHz frequency band.

[3] Estonian Presidency of the European Union 5G roadmap, December 2017, https://www.mkm.ee/sites/default/files/8.a_b_aob_5g_roadmap_final.pdf

[4] "5G: an ambitious roadmap for France": https://www.arcep.fr/fileadmin/reprise/dossiers/programme-5G/Feuille_de_route_5G-DEF.pdf

As part of the work being done to prepare for the advent of 5G, Arcep has already held public consultations on the terms and conditions for releasing and using the 3.5 GHz, 26 GHz and 1.4 GHz[5] frequency bands, to obtain a first set of guideposts on these bands.

The 700 MHz band was already allocated in Metropolitan France[6] in 2015, ahead of the European timetable.

The purpose of this public consultation is to inform Arcep's actions going forward, with a view to future allocations of spectrum resources to introduce 5G technology in the 1.4 GHz, 3.5 GHz and 26 GHz bands in Metropolitan France.

The first section addresses the conditions that will enable 5G to be a vital force for improving competitiveness and innovation in France, notably by consulting stakeholders on the new uses that 5G is expected to enable, and on the obligations that might be imposed on future license-holders to help support these needs.

The following three sections look at the procedures and conditions for allocating the 3.5 GHz, 26 GHz and 1.4 GHz bands, respectively, and in particular the bands' availability and how they might be arranged into channels. They do not, however, address the future selection criteria that might be used in the allocation procedures.

An integral part of Arcep's actions is working to achieve the objectives assigned to electronic communications regulation stipulated in Article L. 32-1 of the French Postal and electronic Communications Code ("CPCE"), and particularly:

- fostering investment, innovation and competitiveness in the electronic communications sector;
- regional development and serving regional interests, and promoting diverse competition in the regions;
- consumer protection and ensuring the satisfaction of all users, including those with disabilities, the elderly and those who have specific needs with respect to accessing services and equipment;
- ensuring fair and effective competition between network operators and the providers of electronic communications services, for the benefit of users;
- promoting efficient use and management of radio frequencies.

This public consultation on the allocation of new frequencies for 5G focuses on allocations for Metropolitan France.

Another public consultation on allocations in France's overseas departments will follow, with a view to designing an allocation procedure for these locations.

[5]
- Public consultation on new frequencies for the regions, businesses, 5G and innovation: https://www.arcep.fr/uploads/tx_gspublication/synth-consult-frequences-5g-entreprises-juin2017.pdf
- Public consultation on freeing up the 26 GHz band: https://www.arcep.fr/uploads/tx_gspublication/synth-consult-frequences-5g-26_GHz-juil2018.pdf
- Public consultation on using the 1500 MHz band for 5G: https://www.arcep.fr/uploads/tx_gspublication/consult-5g-band-L-juil2018.pdf

[6] https://www.arcep.fr/actualites/les-communiques-de-presse/detail/n/larcep-delivre-leurs-licences-aux-laureats.html

# Part 1. Fostering innovation thanks to 5G

As the Arcep report on the issues and challenges surrounding 5G[7] demonstrated, 5G will make it possible to improve the performance of the mobile networks and services that are already being provided to 2G, 3G and 4G network users. Given the technical properties of 5G, and the high frequency bands identified for pioneer rollouts, it seems especially well suited to meeting vertical market players'[8] specific mobile connectivity needs. In keeping with its pro-innovation approach to regulation – which it identified in its 2016 strategic review[9] as one of the four pillars of its actions – Arcep is especially committed to ensuring that the future 5G allocation procedure(s) will help create an environment that will bolster French businesses' competitiveness and allow their capacity for innovation to flourish. The goal is to enable "verticals" to become more efficient and develop new applications, and to create a framework where the development of innovative services for a wide range of users can thrive.

## 1.1 Technological disruptions and new uses

5G is the new generation of mobile networks introduced by the electronic communications industry and standardisation bodies. It is a response to the International Telecommunication Union (ITU) "IMT-2020" initiative which defines the main performance categories that these new technologies will make achievable.

If the process of introducing a new technology on new frequencies will make it possible to provide the networks with increased capacity, 5G is above all synonymous with several major technological disruptions in the arena of wireless mobile electronic communications:

- enhanced Mobile BroadBand (eMBB):
  - Introducing ultrafast mobile broadband with theoretical speeds that are at least 10 times faster than those supplied by existing technologies;
- massive Machine Type Communication (mMTC:) Internet of Things (IoT):
  - 5G is expected to enable a dramatic increase in the density of connected objects by surface area, the massive and simultaneous connection of a very large number of objects with, among other things, heavily decreased energy consumption to substantially increase the battery life of the thus connected objects;
- ultra Reliable Low Latency Communication (uRLLC) network:
  - this segment includes use cases that require guaranteed and highly reactive network access, hence very low latency for communications carried over 5G connections;
- the "bespoke" network:
  - this final notion concerns a technology called network slicing, which makes it possible to both manage quality of service end-to-end, and to organise the networks

[7] https://www.arcep.fr/uploads/tx_gspublication/rapport-enjeux-5G_mars2017.pdf

[8] in this document, the term "verticals" refers to all private sector companies regardless of their business area, and by extension public sector structures whose electronic communications needs are comparable to those of private sector companies.

[9] Final report on Arcep's strategic review: http://www.arcep.fr/uploads/tx_gspublication/rapport-final-revue-strategique-janv2016.pdf

so that services that require different levels of performance can coexist on the same network.

These improved performances are expected to enable the development of new innovative services that could not have been provided using existing technologies, or at least not with the same ease or flexibility.

Below is a non-exhaustive list of new uses and applications that will become possible, or will be delivered on an unprecedented scale with 5G:

- 4K-UHD[10] and 8K[11] very high resolution video, both in downlink streaming to improve viewing quality, but also uplink for professional applications such as real-time image analysis from high resolution cameras, for detecting abnormalities in a manufacturing setting or for public safety purposes;
- 360° wireless virtual reality, either mobile or in those environments that are not conducive to a fixed connection, for a range of uses such as games, education, professional training and tourism;
- high speed, low latency connectivity between vehicles and transport infrastructure, and vehicle-to-vehicle, or for in-car entertainment applications;
- remote monitoring, operation and reconfiguration of manufacturing machines and robotised production chains that can be quickly and easily reconfigured without having to install cables;
- end-to-end logistical tracking of a very large number of parcels or items, notably in large sorting hubs such as ports, airport zones, railway stations and road transport logistics bases;
- recovering data from the multitude of smart city sensors, for instance, to monitor traffic and various pollution levels;
- a wide range of remote operations, thanks to low latency and the use of very high accuracy video images, e.g. in the areas of health or mining operations;
- high precision herd tracking for farms thanks to livestock sensors.

**Question No. 1. What kinds of new uses or improvements to existing uses do you expect to see with the introduction of 5G? Who will the users be? To what extent is 5G important to the development of these new uses? What alternatives to 5G could support them?**

To different and varying degrees, these uses will rely on the technological disruptions ushered in by 5G, and will require different performance guarantees for all or some of the following criteria:

- range;
- throughput;
- mobility;
- power consumption;
- latency;
- availability;
- QoS guarantees.

[10] 4K-UHD: Ultra High Definition TV resolution (UHDTV-1), or 3840 × 2160 pixels

[11] 8K: Ultra High Definition TV resolution (UHDTV-2) of 7680 × 4320 pixels.

**Question No. 2. What are the key performances criteria for the new uses listed in your answer to question 1? Is having a mobile network that delivers these performance levels enough to enable the emergence and development of these new uses, or are there other (technical, economic, regulatory, organisational…) prerequisites? If so, can you provide exact details on the impediments you have identified?**

These new uses could emerge thanks to the creation of a powerful ecosystem of players that have made long-term commitments, which can take time.

**Question No. 3. Within what timeframe do you expect to see the emergence of an environment that is mature enough to enable the new uses listed in your answer to question No. 1?**

Moreover, because the technologies need to be standardised, and compatible equipment needs to be available, all of these new uses might not be possible as soon as pioneer 5G networks are available.

For instance, the 3GPP[12] standard plans on finalising Release 16 which concerns improvements for massive IoT and ultra Reliable Low Latency Communication (uRLLC) networks for early 2020, and so providing the technological structure for deploying networks capable of these performance levels at that time.

**Question No. 4. In addition to the 5G standardisation roadmap, what do you expect the timeframe will be for the deployment and actual use of the above-mentioned technologies: i.e. eMBB, mMTC, URLLC, network slicing?**

## 1.2 Facilitating 5G use to drive innovation

### 1.2.1 Giving verticals the means to innovate and be more competitive thanks to 5G

A great many businesses today use narrowband Private Mobile Radio (PMR) networks – for security applications, for instance – in frequency bands below 470 MHz.

Arcep held a public consultation from 6 January to 6 March 2017 entitled, "New frequencies for the regions, businesses, 5G and innovation". When it published the summary of the consultation[13] on 22 June 2017, Arcep stated its plans to devote the middle 40 MHz of the 2.6 GHz TDD band (i.e. the 2575 – 2615 MHz sub-band) to the creation of networks that satisfy the needs of ultrafast PMR.

A consultation was launched in March 2018[14] on the procedure that Arcep would use to allocate these frequencies, along with the obligations that would be written into the licences issued to the operators of ultrafast PMR in the band (using LTE technology) in Metropolitan France. Arcep is currently in the process of analysing and drafting the final document that specifies the procedures for allocating the 2.6 GHz TDD band.

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[12] 3rd generation partnership program http://www.3gpp.org/release-16

[13] https://www.arcep.fr/actualites/les-communiques-de-presse/detail/n/larcep-publie-la-synthese-des-contributions-a-la-consultation-publique-de-new-frequences-po.html

[14] https://www.arcep.fr/actualites/les-consultations-publiques/p/gp/detail/modalites-dallocation-des-frequences-de-la-band-26-ghz-tdd-pour-les-networks-mobiles-a-tres-haut.html

Plans for the band will be primarily 4G-based, and could no doubt evolve towards 5G as the equipment available for these frequencies evolves.

**Question No. 5. As a user of private mobile radio networks, do you believe that, in addition to the networks that may be deployed in the 2.6 GHz TDD band in 4G, and possibly in 5G further down the road, that another 5G network will be needed to meet your needs in other frequency bands? In which bands, and for what reasons?**

5G is seen as an accelerating force in the economy's digitisation, especially in the agricultural, manufacturing and services sectors and, for instance, for:

- smart factories;
- logistics hubs such as ports;
- smart cities;
- the eHealth sector;
- connected vehicles.

These innovative services will each have their own set of specific performance issues and challenges. And, with 5G, they will benefit from the ability to adapt the network's configuration to them. Network slicing introduced with 5G creates the ability to build a "bespoke" network based on the type of application, that will be able to adapt and reconfigure itself dynamically by delivering the needed performance metrics on-demand, according to the target uses.

These services will also be able to benefit more and more from the virtualisation of certain 5G network functions, notably core network functions, as virtualisation technologies become more mature. Virtualised solutions create the ability to use generic equipment, like the hardware deployed in datacentres, and which are not dedicated to the network's functions as has been the case with networks deployed up to now. This means that 5G networks will be able to have network connections and users' virtual network functions (VNF) coexist on the same equipment. Having these functions located on the same networks should help improve the performance of the services provided to end users, notably in terms of latency, e.g. for multi-access edge computing solutions that process data as close to end users as possible.

**Question No. 6. Do you believe that a public 5G network can satisfy your needs as a "vertical" market player? If not, for which technical or performance-related reasons? Aside from network connectivity, what are the other services provided by operators that you deem necessary, such as hosting functions (virtual network functions, multi-access edge computing…) on their network? How long will it take to ensure the viability of business plans for the new applications being planned?**

### 1.2.2 New market players to energise competitiveness and innovation

Some of the new techniques that 5G promises to deliver could enable the emergence of new players that specialise in certain types of electronic communications service.

For instance, innovative 5G core network architectures that rely on cloud technologies and data centres should enable specialised players to supply their electronic communications service thanks to virtualised functions, hosted directly on the network's infrastructures.

By the same token, the multiple dimensions of the 5G New Radio (NR) interface's performance could enable the emergence of new players that are specialised in markets designed to meet specific needs. For instance, companies that specialise in connected objects that require either high-level connectivity or very low latency, or players that specialise in coverage, including indoor coverage and coverage for complex sites.

These new players would not necessarily be the network's owners, or frequency licence-holders, but could have access to other operators' networks or to a portion of them, to be able to deliver their services to end users, as with mobile virtual network operators (MVNO) which today can provide services using the networks of operators that hold frequency licences.

**Question No. 7. To what extent could the specific properties of 5G enable the emergence of operators that specialise in certain services? For what types of service? What would their business model be? Through what mechanism would they access spectrum? Network infrastructures?**

**Question No. 8. Could the MVNO model create a more competitive and innovative 5G services market? Should special provisions be written into future licences for enabling alternative players' access to 5G spectrum or infrastructure? If so, which provisions?**

## 1.3 5G rollouts: technical aspects

### 1.3.1 The frequency bands

The following section examines the frequency bands that could possibly be used for 5G. Because the 3.5 GHz, 26 GHz and 1.4 GHz bands are the central focus of this consultation, the questions relating to them, and in particular their availability and the procedures for allocating them, are described in greater detail, in parts 2, 3 and 4, respectively of this public consultation.

#### a) New bands identified for 5G in Europe

Certain frequency bands have been harmonised, or are in the process of being harmonised in Europe as pioneer bands for the introduction of 5G:

- The 703 – 733 MHz and 758 – 788 MHz frequency bands in FDD (frequency division duplexing) mode;
- The 3.4 – 3.8 GHz frequency band in TDD (time division duplexing) mode;
- The 24.25 – 27.5 GHz frequency band in TDD mode.

The 700 MHz band was already allocated in Metropolitan France[6] in 2015, ahead of the European timetable. All or a portion of the two other frequency bands are to be assigned to wireless electronic communications.

#### b) Bands already assigned to mobile networks

The frequency bands that are already being used by public mobile networks could also be used for pioneer 5G rollouts since these bands have already been defined by standardisation bodies, and the licences awarded for their use are technology-neutral.

**Question No. 9. Within what timeframe is a 5G rollout possible in the bands that have already been allocated (700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2.1 GHz, 2.6 GHz FDD)?**

#### c) Other frequency bands

Other bands were recently harmonised for Europe to enable a Supplemental DownLink (SDL), to be used in conjunction with one or more other FDD frequency bands, both to provide an uplink connection and increase downlink speeds. One example is the 1427 – 1518 MHz frequency band.

**Question No. 10. Do you see other possible frequency bands for 5G rollouts? Within what timeframe?**

**Question No. 11. Would you be interested in seeing the 738 – 753 MHz band used to enable an SDL for 5G or another technology? Within what timeframe?**

### 1.3.2 Defining the characteristics of a generic 5G service

5G promises to deliver a great many technical improvements to radio networks. The purpose of the following sections is to shed light on 5G network performance, and to query stakeholders on how the supply of a generic 5G service could be characterised.

5G services could be defined by all or some of the performance criteria detailed below.

#### a) Speed

The introduction of 5G will increase spectrum efficiency considerably compared to existing technologies. This increased performance is made possible by the introduction of new techniques such as:

- MIMO (Multiple Input Multiple Output) and beamforming which – thanks to the use of base stations made up of a large number of transmitters/receivers – makes it possible to achieve highly directive antenna beams and thereby match signal power to need. Beam management makes it possible to spatially separate communications occupying the same frequencies, in addition to reducing potential interference between communications and between cells;
- Reducing the weight of signalling in radio frames that enable optimisation of the bandwidth dedicated to payload:
- Better use of payload spectrum per carrier, and particularly wide channel bandwidths, to optimise the per-MHz data rates;
- coordination between cells to reduce cell edge interference;
- dynamic TDD management of the radio frame structure, notably with rapid adaptation of downlink and uplink ratios based on traffic, to reduce interference and adapt bandwidth to traffic asymmetries in real time.

For users, this improved spectrum efficiency must translate into a substantial improvement in the bandwidth capable of providing enhanced mobile broadband (eMBB) services.

The supply of 5G ultrafast mobile access outdoors should, for instance, reach theoretical downlink speeds of at least 100 Mbit/s in 10 MHz, which corresponds to a theoretical downlink speed of 1 Gbit/s in a 100 MHz simplex carrier frequency.

#### b) Latency

Another improvement expected from 5G is reduced latency end-to-end, which opens the way for the supply of connected services that require very high reactivity and which, up until now, could only be provided in a fixed environment.

This improvement derives, among other things, from the following techniques:

- Substantially reduced packet received acknowledgement time;
- Dynamic management of radio frame structures when employing TDD.

Providing low latency mobile access outdoors over 5G should, for instance, make it possible to achieve end-to-end latency of under 5 milliseconds (ms).

c) Connection density

5G technology must enable a substantial increase in the number of connected objects per surface area unit, compared to existing technologies, including 4G. This increase is made possible in particular by stripped down connection protocols that employ only a tiny fraction of the bandwidth.

Providing massive access for connected objects in 5G, both outdoors and indoors should, for instance, enable a connection density of several hundred thousand objects per km².

d) Reliability

Some of the planned new uses enabled by 5G networks require a more reliable connection and an unavailability percentage that is reduced to a minimum.

The dual connectivity and Hybrid Automatic Repeat Reques*t* (HARQ) techniques that are planned for 5G should help limit packet loss and made connections more reliable.

The virtualisation of certain parts of 5G networks should also make them more resilient, and so improve the reliability of network connections.

And ultra-reliable 5G outdoor connection could, for instance, have an availability rate of 99%.

**Question No. 12. How long do you think it will take for the improved technical performance introduced by 5G listed above to reach maturity? Are there any spectrum-related impediments that might hamper the deployment of these techniques? Are the performance levels cited above relevant? Are other ones needed? Why?**

### 1.3.3 5G rollout scenarios

The aim of this section is to lay out the different possible 5G architectures and rollout solutions, to then determine the potential impact on performances and 5G network access.

a) 5G core network and links with existing 4G networks

Existing networks' gradual upgrade to 5G has been taken into account in the three main deployment architectures for 5G radio technologies defined by the 3GPP release 15[15] standard.

**Non Stand Alone (NSA), 4G core deployment**

5G deployment with this solution is gradual, and allows existing networks to evolve to 5G in a flexible fashion. 5G is deployed in addition to an existing 4G network or a network deployed concurrently. 4G radio access remains the anchor point and the vehicle for communication control signalling, while the user plane traffic is shared between 5G and 4G radio access, via dual connectivity which enables the aggregation of 4G and 5G carrier bandwidth.

This solution thus makes it possible to eliminate the need to deploy a new 5G core network at the outset, by taking advantage of the performance gains enabled by the 5G radio interface, albeit without the expected benefits of a 5G core network, notably slicing.

**Non Stand Alone (NSA), 5G core deployment**

In this solution, a 5G core network and 5G wireless access are deployed. Existing 4G base stations are kept initially, and connected to the 5G core network to ensure dual connectivity with 5G.

[15] https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3056

Compared to the previous solution, this architecture should deliver all of the leaps in performance expected from 5G thanks to the introduction of a 5G core.

**Stand Alone (SA), 5G core deployment**

Here, 5G is deployed like a new network, end-to-end, including base stations and network core (parallel to the existing network if the license-owner is already an operator with previous allocated frequencies).

There is no interaction between the 5G network and existing networks, aside from the ability to switch from one to the other through inter-system handover procedures.

In theory, this end-to-end 5G solution enables all of the expected leaps in performance, aside from those delivered by dual connectivity.

**Question No. 13. What are the main pros and cons of the three rollout solutions (NSA with 4G core, NSA with 5G core and SA with 5G core)? What impact will the three solutions have on the expected increase in performance? Depending on the ecosystem's maturity, what timeline is possible for a 5G core deployment? What would be the RoI timeline for the different scenarios?**

**Question No. 14. Regarding full MVNOs, what are the technical prerequisites for the host operator and the full MVNO, to ensure that the latter can be hosted on an ultrafast mobile network? Do these prerequisites differ depending on the host operator's architecture (SA or NSA) and the full MVNO's network core (4G or 5G)?**

### b) Hosting virtualised functions

Thanks to the networks' likely virtualisation, it will be easier for operators to programme new virtual software functions on existing hardware, notably to host functions dedicated to different types of service and groups of users. These functions could be supplied by the users themselves, such as those that are useful for running or monitoring the machines required for certain industries.

**Question No. 15. As an operator, do you plan on hosting functions provided by users (virtual network function, multi-access edge computing…) on your network, to satisfy their service needs? If so, under what conditions? Starting when? If not, what obstacles do you perceive to doing so?**

### c) Complementarity with other access networks

Access networks that complement terrestrial mobile networks could provide the services enabled by 5G.

Amongst these systems, solutions based on satellite networks or fleets of balloons, such as the high-altitude platform station (HAPS), are currently been evaluated.

**Question No. 16. Have you identified any other 5G rollout solutions? To what degree can satellite or HAPS solutions serve to complement terrestrial 5G networks?**

### d) Backhaul

To guarantee that the 5G service provided will be of a high standard, the frequency licence-holder will need to ensure that base station backhaul is equal to the task of undergirding 5G performances, notably in terms of speed and latency, while also ensuring, when applicable, existing technologies' traffic and performance.

**Question No. 17. When 5G is introduced, what level of performance is required to ensure base station backhauling? What differences do you see between the network performance required of wireline backhaul (notably optical fibre) and wireless backhaul? Have you identified any obstacles that need to be lifted to enable this backhaul?**

## 1.4 Obligations written into frequency licences

### 1.4.1 Background

As stated in the introduction to this public consultation, the European Commission introduced an action plan and coverage targets, which were detailed in France's 5G roadmap as follows:

- 5G should be deployed commercially in at least one major city by 2020;
- the main transport corridors (motorways, secondary roads and trans-European railway lines) should be covered by 5G by 2025.

There are already coverage obligations attached to existing frequency licences. They require licence-holders to provide mobile coverage for voice and text and/or data services.

Depending on the frequencies allocated, obligations apply either nationwide or to an area in particular (e.g. an obligation to cover departments or priority rollout areas), in some instances with dedicated mechanisms designed to meet regional digital development imperatives – such as the town centre white area programme, or the targeted coverage scheme written into the terms of existing 900 MHz, 1800 MHz and 2.1 GHz band licences.

Today, these coverage obligations take one of two forms: first, covering a certain percentage of the population in a given area by a set deadline and, second, covering transport corridors (road and rail). Requirements in terms of both timelines and levels were strengthened under the New Deal for Mobile in 2018, which resulted in amendments to the terms of mobile operators' existing 900 MHz, 1800 MHz and 2.1 GHz[16] band licences.

Moreover, 2.6 GHz band licence-holders have an obligation to provide an ultrafast mobile access service to 75% of the population within 12 years of having obtained their licence. This percentage increases to 99.6% of the population within 15 years of having obtained their licence for 700 MHz and 800 MHz band licence-holders.

In addition to these existing obligations, the question of whether to create new obligations that will be imposed on the winners of future spectrum allocations is addressed in subsequent sections.

### 1.4.2 Population coverage

The purpose of this section is to determine the population coverage obligations for Metropolitan France that will apply to the frequencies that will be allocated to deploy 5G services.

[16] https://www.arcep.fr/actualites/les-communiques-de-presse/detail/n/new-deal-mobile-1.html

The first bands identified for 5G deployments, and which will be part of a new allocation procedure, are the high frequency (3.5 GHz) and millimetre wave (26 GHz) bands. Because radio wave attenuation increases as we move up the spectrum, these bands have different physical coverage capabilities:

- the 26 GHz band has a bandwidth that should make it possible to achieve datarates of several gigabits per second, but only be over a range of several hundred metres, at most;
- the 3.5 GHz band could enable 5G coverage that is roughly on par with the coverage provided by the 1800 MHz frequency band, by reusing existing networks' mesh, and thanks to the introduction of beamforming techniques. To give an idea, applying the hypothesis that all current cell sites are 4G enabled using the 1800 MHz band, at first approximation and based on theoretical knowledge, this mesh could correspond to coverage of around 90% of the population. This coverage would thus be likely to provide a 5G service in the main urban areas and economic zones.

In addition, the 700 MHz band, which has also been identified as a pioneer band for 5G in Europe, has been allocated in Metropolitan France since 2015. Its propagation qualities would enable it to cover a larger percentage of the country than the two other above-mentioned bands, but has narrower channels, which would hamper connection speeds in particular. Over the longer term, other low frequency bands could be used to expand 5G coverage across the country, and come to flesh out the coverage provided by the bands that are the subject of this consultation.

The use of lower frequencies for 5G will nevertheless be restricted in the short to medium term by the fact that some of them (the 800 MHz and 900 MHz bands) are currently being used extensively by 2G, 3G and 4G networks.

**Question No. 18. What impact do the different types of environment (urban, suburban, rural) have on 5G coverage in the 3.5 GHz band? What percentage of the population is this band capable of covering, taking the different considerations into account (range, costs, opportunities, etc.) and within what timeframe?**

**Question No. 19. Within what timeframe and for which services do you plan (if you plan) to employ your 700 MHz band frequencies? Your 800 MHz and 900 MHz band frequencies? With the frequencies identified for 5G, will the technological developments make it possible to deliver the faster connections promised by 5G, to a larger percentage of the population? What solutions would enable you to achieve this?**

**Question No. 20. Which frequency bands would be the best suited, if applicable, to achieving an obligation to provide widespread 5G coverage of the population?**

Unlike the bands cited earlier, the 26 GHz frequency band has a very limited range, and the 1.4 GHz band is primarily a capacity boosting band that needs to be paired. Setting coverage obligations for these two bands does not, at first glance, seem apposite.

Despite which, a quantified network rollout obligation in these frequency bands over the life of the frequency licences could be considered.

**Question No. 21. What specific obligations could apply to a network (coverage obligations or other mechanisms) operating in the 26 GHz and 1.4 GHz frequency bands? With what timetable?**

### 1.4.3 Launching 5G services

To guarantee the availability of a generic 5G service, as defined in section 1.3.2, it may be pertinent to ensure that the service is being provided over a large portion of the network, starting on a given date, provide the licence-holder already has a network.

The same applies to the supply of enhanced 5G services that make use of features such as network slicing, which could be introduced after a 5G service's commercial launch, when the 5G network core is not deployed at the same time as the rest of the network.

**Question No. 22. Should a start date be set for the supply of a generic 5G service? If so, what date?**

**Question No. 23. In the event that a licence-holder that already owns a mobile network wins a future spectrum allocation procedure, should the obligation to provide 5G services by a set date apply to all or only a portion of its current network?**

**Question No. 24. Should a start date be set for the supply of an enhanced 5G service based on network slicing features? If so, what date?**

### 1.4.4 Covering transport corridors

This section addresses 5G coverage targets for transport corridors.

Deploying 5G for transport-related uses is a particularly vital issue. Here, the European Commission's action plan and the 5G Roadmap for France have set a target of covering all of the main transport corridors by 2025.

In France, existing frequency licences already carry an obligation to provide voice and text and ultrafast mobile access services on the main roadways and on everyday rail services, as defined in current licences[17], which is on a larger scale than what the European Commission is considering.

This means that mobile operators that have been frequency licence-holders since before 2010 have an obligation to cover all of the priority roadways (i.e. around 55,000 km of roads, including all of the country' motorways) for voice and text and superfast mobile access, outside vehicles, by the end of 2020.

Regarding the regional railway network (or around 23,000 km of railway lines[18], not including high-speed rail), operators with a licence to operate in the 700 MHz band have an obligation to provide ultrafast mobile services on 90% of this network, notably on-board trains, by 2030.

In addition, operators that were awarded 1800 MHz band frequencies in 2018 have an obligation to provide ultrafast mobile services on 90% of France's regional railway network by 31 December 2025 at the latest.

Similarly, future frequency licences could carry an obligation to provide 5G coverage to these same transport corridors, within an as yet to be determined timeframe. However, the fact that 5G should enable specific quality of service levels, on the one hand, and innovative services, on the other, raises

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[17] https://www.arcep.fr/demarches-et-services/collectivites/les-definitions-des-networks-ferres-regionaux-et-axes-routiers-prioritaires.html

[18] i.e. regional express trains (TER) in the regions of Metropolitan France outside of Ile de France and Corsica, express regional network trains (RER – A, B, C, D, E lines) in Ile de France, and the Transilien commuter network (H, J, K, L, N, P, R, U lines) in Ile de France and Corsica's rail network.

the question of how to define a new obligation for future licences, to provide for increased quality of service or coverage of other transport corridors.

**Question No. 25. To what extent, and for which service(s) does requiring 5G coverage of transport corridors, as defined in existing licences, seem like an appropriate measure to you? By what date? Do QoS targets need to be set? If so why, and which ones? What would the cost of this be?**

**Question No. 26. Do you think it is necessary to plan on imposing a coverage obligation for other transport corridors? With what level of service and within what timeframe? Why? What would the cost of it be? Which frequency bands do you believe are best suited to the task?**

### 1.4.5 Effective spectrum use

Arcep can impose an obligation on licence-holders to actually use the spectrum they have been allocated by a set deadline, or risk having their licence rescinded.

An obligation of this kind could be defined for all of the frequency bands being discussed in this consultation.

**Question No. 27. What do you think are the most relevant criteria to apply to effective spectrum use? Should they be specific to each band or generic, and why? What verification mechanisms should be attached? What deadline should apply?**

### 1.4.6 Specific coverage to satisfy verticals' needs

To be able to satisfy vertical market players' specific needs, the future allocation procedure(s) could include provisions aimed at ensuring that frequency licence-holders grant all reasonable requests for service from verticals, if 5G coverage is not available, or if the 5G network's performance fails to meet the applicants' needs.

A frequency licence-holders could grant reasonable requests for service in several ways, for instance by deploying a 5G solution tailored to the applicant's specific needs, on demand, and by selling the service at a reasonable price, or by make frequencies available to a third party, which could be the applicant itself, so that this third party might build and operate the network to provide the requested service.

**Question No. 28. As a "vertical" player, would you be wiling to build your own network with the frequencies made available by a licence-holder, and under what conditions? Over what geographical area? How should competition issues be taken into account in this situation?**

**Question No. 29. As an operator, how could you satisfy reasonable requests for service from verticals in areas that are not covered, or when the existing network does not deliver the required performance levels? What would be the technical restrictions and challenges tied to having networks operated by different players cohabitate on the same frequencies?**

### 1.4.7 Indoor coverage

In the allocation procedures that were launched as a result of the New Deal for Mobile that was announced in January 2018, candidates for 2.1 GHz band frequencies had the option of committing to marketing a solution that enabled businesses or public entities that so requested to obtain better indoor coverage, at a reasonable price, from all of the operators that made this commitment.

A provision of this kind could be envisioned for the future allocation procedure(s). Moreover, in those cases where the quality of indoor 5G coverage is unable to meet users' specific needs, it may prove necessary to include provisions in the terms of the frequency licences for granting reasonable requests for service in these locations.

**Question No. 30. What indoor coverage performance will 5G deliver, particularly compared to current networks? Will 5G require special equipment such as small cell solutions or a Distributed Antenna System (DAS) to provide indoor coverage? Would it be apposite to impose the same types of indoor coverage commitments as those included in the call to tender for the 2.1 GHz band? Would other types of provision be needed to improve 5G indoor coverage?**

### 1.4.8 Mobile network sharing

The issues and challenges surrounding 5G rollouts raise the question of whether mobile network sharing[19] schemes could accelerate the pace of coverage for certain sparsely populated areas across the country, or to overcome complex rollout issues (e.g. lack of available space, especially hard to reach areas, etc.).

Because of rollout complexities, the issue of infrastructure sharing may arise, particularly if the network is composed of a large number of small cells, whose deployment involves the use of street furniture (street lighting, shelters, façades), which could be especially common with high and millimetre wave frequencies.

Network sharing could also be seen as a way to facilitate coverage in more sparsely populated areas, under certain conditions, especially by reducing rollout costs, or improve available speeds (e.g. by sharing frequencies).

Several legislative and regulatory provisions have already been issued on mobile network sharing. The French Postal and Electronic Communications Code (CPCE) contains measures aimed at encouraging passive sharing of radiofrequency sites, and defines passive infrastructure access rights.

The Act of 6 August 2015[20] also gives Arcep the power to request that the terms of sharing agreements for public radio networks be amended. To provide stakeholders with clarity on this issue, in May 2016 Arcep published its mobile network sharing guidelines[21]. It contains an analytical grid for assessing mobile network sharing agreements with respect to regulatory objectives, and describes the procedure that Arcep employs when examining sharing agreements, based on CPCE Article L.34-8-1-1.

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[19] Mobile network sharing involves having several operators share all or a portion of the equipment that makes up their mobile networks. In some instances, mobile network sharing can also include sharing radio frequencies.

[20] CPCE Article L. 34-8-1-1 created by Act No. 2015-990 of 6 August 2015 on Growth, economic activity and equal economic opportunity.

[21] http://arcep.fr/uploads/tx_gspublication/2016-05-25-partage-networks-mobiles-lignes-directrices.pdf

**Question No. 31. In addition to the existing framework, do you believe it would be useful to take additional mobile network sharing measures for 5G rollouts? If so, which ones and why?**

### 1.4.9 Conditional frequency use

To enable both effective and efficient spectrum use, there are mechanisms in place in some countries that allow the holder of an individual licence to all or a portion of a frequency band to use other frequencies in that same band when all or a portion of them are not being used by their licence-holders.

A licence-holder thus has a guarantee that it will not encounter interference on the portion it was allocated, and is authorised to use the remainder of the band provided it does not cause interference with the other licence-holders.

A mechanism of this kind could be considered as part of the future allocation procedure(s) for 5G frequencies: the interested parties would submit a tender for the blocks for which they want to hold the licence (unconditional rights of use) but also to be allocated conditional rights of use to other blocks. These latter rights could only be granted if the licence-holder with unconditional rights of use over the block is not using its frequencies in a given area, and if it is guaranteed no interference.

To ensure that this conditional frequency use runs smoothly, it may be necessary to introduce an obligation to keep other licence-holders informed of the planned use of a block, in a given area, in particular to prevent any risks of interference. Notice periods could also be put into place for when the licence-holder with unconditional rights of use wants to be able to use all of its frequencies in a given area.

**Question No. 32. What do you think of such a mechanism for granting conditional rights of use? What do you think of the obligation to provide other licence-holders with information on the planned use of the block in a given area? What information would need to be provided? What conditions would ensure that such a mechanism runs smoothly (operational, technical, regulatory, contractual terms and methods)?**

Moreover, in the event where the allocated frequency band is not available in its entirety, either temporarily or locally, the question arises of providing access to the rest of the band to the licence-holders whose authorisation is for frequencies that are not available.

**Question No. 33. In a situation where there are restrictions on the use of a portion of the band, does there need to be a provision in place that allows the licence-holders affected by these restrictions to have access to the other licence-holders' frequencies? How would this mechanism work?**

### 1.4.10 Adapting obligations

Given the pace of innovation, and the demand that it will drive in an increasingly digital economy, it is hard to get a clear picture of all of the applications and needs that mobile networks, and 5G in particular, can enable and satisfy, whether looking at connected car deployments, for instance, or the advent of smart cities.

As a result, to create an environment that fosters competitiveness and allows innovation to thrive throughout the life of the frequency licences, it may prove necessary in objectively justified cases, and in a proportionately reasonable fashion, to adapt the initially planned obligations, notably to achieve the regulatory objectives set out in CPCE Article L. 32-1.

The procedural conditions for making these possible changes would be defined concurrent with the allocation procedure, to guarantee that frequency licence-holders have the clarity they need.

**Question No. 34. How long will it take to ensure the viability to stakeholders' business plans? How to reconcile the predictability needed for investments and adapting obligations to future needs? Do you have any suggestions on how to adapt obligations with regard to the development of 5G?**

# Part 2. The 3.4 GHz – 3.8 GHz band

## 2.1 Definition of the band

European Commission Decision 2008/411/EC[22] harmonises the technical conditions governing the use of 3400 – 3800 MHz band spectrum, using time division duplexing by blocks of 5 MHz, as follows:

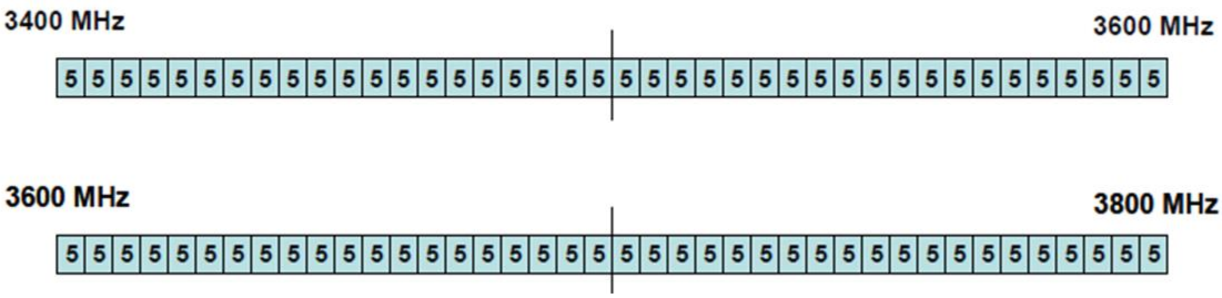



Figure 1 Harmonisation of the 3.4 – 3.8 GHz band by the European Commission

Work is currently underway in Europe to update the terms of use stipulated in the European Commission Decision, to make it compatible with 5G.

Meanwhile, 3GPP[23] has defined the n78 band for 5G TDD use as follows:

| NR *operating band* | Uplink (UL) *operating band* BS receive/UE transmit $F_{UL\_low} – F_{UL\_high}$ | Downlink (DL) *operating band* BS transmit/UE receive $F_{DL\_low} – F_{DL\_high}$ | Duplex Mode |
|---|---|---|---|
| n78 | 3300 MHz – 3800 MHz | 3300 MHz – 3800 MHz | TDD |

Figure 2 3GPP definition of the n78 5G band

The plan is therefore to allocate the 3.4 GHz – 3.8 GHz band only with a TDD structure as stipulated in the European Commission's revised harmonisation Decision. This revision is due to be adopted by the Radio Spectrum Committee (RSCOM) by the end of 2018.

## 2.2 The band's availability

The band is currently occupied by different types of user, including:

- satellite systems' earth stations;
- The Ministry of the Interior's radio relay systems;
- systems whose frequency licences expire on July 2026 or later.

Arcep is dedicated to making the 3.5 GHz band as fully available as possible, with a view to its allocation for 5G. It has taken actions with the other entities responsible for allocating this band, and those with licences to use it, in order to begin rearranging it.

[22] https://eur-lex.europa.eu/legal-content/FR/TXT/PDF/?uri=CELEX:32008D0411&from=EN

[23] 3GPP TS 38.104 V15.1.0 (2018-03) Base Station (BS) radio transmission and reception, reference documents for defining frequency bands.
https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3202

Rollouts performed in the band, and the rollout obligations attached to the licences are both monitored. Should the licence-holder fail to meet these obligations, the competent Arcep body can adopt penalties in accordance with the legislative and regulatory framework set out in the CPCE[24].

### 2.2.1 After July 2026

After 2026, a guard band will be needed to prevent interference with the Ministry of the Armed Forces' radars operating below 3.4 GHz, to guarantee power limits as recommended by the European Conference of Postal and Telecommunications Administrations (CEPT)[25] in this portion of the spectrum. This guard band is currently estimated by the industry at between 10 to 20 MHz, but could potentially be reduced as radio equipment improves.

**Question No. 35. What guard band will be needed to ensure that 5G equipment is capable of complying with the power limits defined by CEPT, while ensuring its coexistence with the Ministry of the Armed Forces' radars using frequencies below 3.4 GHz? Within what timeframe do you think it will be possible to employ a narrower guard band?**

### 2.2.2 Before July 2026

Up until July 2026, the 3.4 – 3.8 GHz band will be allocated to different players, including:

- Broadband wireless network operators and wireless local loop (WLL) WiMAX network operators in a number of departments in France. Broadband wireless networks use the 3410 – 3460 MHz band. Arcep has opened the window for allocating these frequencies for broadband wireless, at this stage up until the end of 2019. In some departments, WiMAX networks also use 30 MHz spread out over the 3410 – 3580 MHz band;
- Bolloré Telecom has a licence to two 15 MHz of blocks of spectrum. These blocks could be rearranged into a single block whose final position has not yet been determined. It could be in the 3460 – 3490 MHz band and in the 3410 – 3460 MHz band in those departments where this band has not been otherwise allocated;
- SHD has a licence to two blocks of 15 MHz of spectrum in the Provence-Alpes-Côte d'Azur and Ile-de-France regions. These blocks could be rearranged into a single block whose final position has not yet been determined. It could be situated either in the 3410 – 3460 MHz band (broadband wireless band) in those departments where this band has not been otherwise allocated, or in the 3490 – 3520 MHz band;
- different users of satellite earth stations that have licences up to 2023 for the 3700 – 3800 MHz band.

To conclude, up until July 2026, and without prejudging the guard bands that may be required:

- if no rearrangement occurs (as it stands today), 220 MHz will be available for assignment to 5G;
- if a rearrangement occurs, and depending on the scenarios chosen, between 280 and 340 MHz will be available for assignment to 5G;.

[24] CPCE Art. L. 36-11 and D. 594 et seq.

[25] https://www.ecodocdb.dk/download/5ffb56c9-9c78/ECCRep281.pdf

**Question No. 36. Would you be interested in obtaining a licence that would be valid from 2020 and 2026, to use frequency bands that are only available in certain departments in France? What conditions in terms of the blocks' geographical contiguity do you think are important?**

The need for clarity, insofar as possible, on the frequencies that will be available for the allocation planned for mid-2019 – notably due to the coexistence constraints described in in section 2.4 – raises the question of whether to hasten the timetable for broadband wireless, and require tenders to be submitted sooner, before the end of the Q1 2019.

**Question No. 37. If the timetable for broadband wireless were to be shortened, what difficulties would it cause?**

## 2.3 Using wireless solutions to ensure the continuity of a fixed access service

In certain departments, the 3410 – 3460 MHz band will be used up to 2026 for broadband wireless or WLL networks, and in other departments a portion of the 3410 – 3580 MHz band could potentially still be used by WLL networks.

This therefore raises questions over the supply of a fixed access service in the areas in question, ensuring continuity for the service's coverage when the licences expire.

**Question No. 38. If applicable, do you see any difficulty in providing a fixed access service in this band with 5G, after 2026 or up to that date, to ensure coverage continuity for the service that has been provided by broadband wireless and WLL in the areas in question? Do you think that other technical solutions could be considered to provide this type of service?**

## 2.4 Coexistence of 3.4 GHz – 3.6 GHz band allocations

For the band to be used in TDD mode, techniques for ensuring the coexistence of several users need to be implemented to avoid interference.

When using frequencies in FDD mode, the duplex gap between the uplink frequencies and the downlink frequencies constitutes the guard band, which eliminates the risk of interference between the two directions of traffic on networks that occupy adjacent channels. TDD, on the other hand, wherein uplink and downlink traffic uses the same frequencies alternatively, can create temporal incidents where two networks in adjacent channels have one transmitting and the other receiving, with the first causing interference with the second.

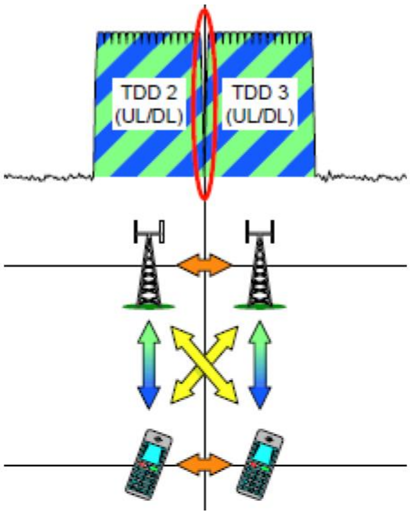



Figure 3: Network interference scenario for TDD

A this stage, three main technical solutions have been identified to enable several users to coexist on two adjacent frequency bands operating in TDD mode:

- The synchronisation or semi-synchronisation of the networks;
- Use of guard bands;
- Spatial separation of the networks.

Contributors are invited to list any other points they believe should be taken into account.

**Question No. 39. Is there any other solution to ensure coexistence that could be implemented thanks to the technological innovations introduced by 5G? Within what time frame?**

The purpose of the following sections is to describe the different solutions that have been identified to date.

This issue of methods to enable networks to cohabitate applies as much to 5G networks between themselves as to 5G networks with the LTE or WiMAX networks that will be using the frequency band until 2026.

### 2.4.1 Synchronisation or semi-synchronisation

The first solution that TDD networks can employ is synchronisation.

The CEPT ECC 216[26] report details the available frame structures and protocols that can be used to ensure sharing between networks with a common time reference, especially for TD-LTE and WiMAX technologies. The CEPT is currently working on defining similar principles in the run-up to 5G rollouts, and notably the coexistence between solutions that use active antennae (enabling beamforming) and those that do not[27].

Synchronised networks use:

- First, the same frame structure, in other words the same time division for the transmission and reception phases between the base stations and customer devices;

[26] https://www.ecodocdb.dk/download/220ac21f-b44b/ECCREP216.PDF

[27] ECC/PT1 work item PT1_17 https://eccwp.cept.org/WI_Detail.aspx?wiid=660

- second, a common time reference for starting the frames at the same time.

The semi-synchronisation solution consists of synchronising the TDD frames' start time, but giving operators a certain freedom to choose the frames' format. Some interference could occur between transmission and reception, but these occurrences would be limited and monitored.

Once the frame is chosen, it is the same for all of the frequency band's users.

**Question No. 40. Are you in favour of implementing synchronisation or semi-synchronisation between TDD networks? For what reasons? If synchronisation, what do you believe the right uplink/downlink time ratio would be? Do synchronisation parameters need to be stipulated in future licences, or defined in concert with the frequencies' licence-holders? What potential impact could this have on performances?**

**Question No. 41. How do you think border coordination of the 3.4 – 3.8 GHz band could be handled? Will synchronisation be necessary?**

### 2.4.2 Guard bands

The second technique to ensure coexistence consists of using guard bands between the frequency bands allocated to each user. They would make it possible to separate transmission and reception frequencies, which would allow them to be simultaneous and limit interference. A similar but more flexible solution to the use of guard bands would be to employ so-called "restricted" blocks of 5 MHz, or more at the extremity of each block of allocated frequencies, to which very strong restrictions on transmitting power are imposed. The outcome is the same as with guard bands (prevent interference between transmission and reception) but makes it possible to use these frequencies.

**Question No. 42. What do you think of the use of guard bands to prevent interference? How wide do you think the guard band needs to be? Do you think the use of restricted blocks is enough to prevent interference, notably between LTE TDD and 5G?**

### 2.4.3 Spatial separation

This final technique does not apply across the board, as some frequencies are being used nationwide, but it can be an interesting option when there are two technologies coexisting in adjacent bands that are not being used for the same application, and do not have the same geographical coverage targets, which may temporarily be the case. Spatial separation – i.e. the introduction of an "exclusion zone" – which therefore corresponds to the minimum distance that separates the installation of two cell sites using the two technologies in adjacent bands. The distance makes it possible to introduce a signal path loss that limits interference between the two sites and their impact on performances. Spatial separation can also provide a solution to the coexistence of two systems operating on the same channels.

This solution does not exclude the use of guard bands which may prove necessary inside the exclusion zones.

**Question No. 43. What do you think of the implementation of spatial separation between broadband wireless sites and 5G sites? What distance do you deem necessary to prevent interference from affecting performances in an adjacent channel? In the same channel?**

## 2.5 Allocation timetable

Because frequency licences have been allocated for broadband wireless and WLL in certain departments, the 3.4 – 3.8 GHz band will not be fully available until 2026. Two allocation timetables are thus possible:

- an allocation procedure in 2019 for the entire band: the entire band will be allocated but licence-holders will initially only have access to part of the band, and then to the entire band in 2026 when it is released by its current users;
- two allocation procedures at two different times: the first allocation procedure in 2019 for only the portion of the band that will be available in 2020, and the second for the frequencies that will become available once the band has been fully released, which will take place before the release occurs.

In both options, frequency licences could provide for a rearrangement of the frequencies in 2026, to ensure that licence-holders are allocated contiguous frequencies, and so promote efficient spectrum use and management, and to enable wider 5G channel bandwidths to achieve better performance levels for 5G services.

**Question No. 44. Which of the two options do you prefer, and why? If applicable, should the expiry dates for future licences be identical? Are there any operational restrictions that would limit the ability to rearrange 5G radio channels and positions in the band after 2026, notably for channels on either side of the 3.6 GHz frequency band?**

## 2.6 Procedure for allocating the 3.4 GHz – 3.8 GHz band

### 2.6.1 Quantity of frequencies

One of the main distinctions between 5G and earlier generations of technology is the ability to deploy networks with very wide channel bandwidths, of up to 100 MHz in the 3.4 GHz – 3.8 GHz band, to achieve very high datarates per user and per cell. The question being raised now is what quantity of frequencies is needed to fully reap the benefits of 5G.

However, because the total amount of spectrum available in this band is restricted, especially up until 2026, it seems difficult to guarantee the availability of several 100 MHz channels.

Because of restrictions weighing on availability, and to ensure fair and equal access to the spectrum, provisions could be introduced that limit the ability to accumulate spectrum – i.e. a spectrum cap imposed on all of the candidates – during the procedure and during the life of the licences. Some countries have thus decided on a spectrum cap of 100 MHz during the procedure.

**Question No. 45. What do you believe is the minimum quantity of frequencies required? What impact would being allocated only 20 MHz have on 5G performances? Same questions for 50 MHz? Same question for 80 MHz?**

**Question No. 46. With 5G, will network equipment make it possible to aggregate several blocks of non-contiguous blocks of frequencies? What are the potential restrictions for the channelling and channel spacing of non-contiguous blocks?**

**Question No. 47. Do you think a spectrum cap is pertinent for this procedure? For the life of the licences? If so, what cap do you think is appropriate? Should it take into account the amount of spectrum that an operator has in other 5G-capable bands?**

### 2.6.2 Appropriate geographical area for frequency licences

The band could be allocated either on a nationwide scale or, as some countries are planning to do, on a local grid level, for instance on a regional or department-wide scale.

Awarding frequencies on a local scale could, in particular, make it possible to issue frequency licences in departments where the frequencies will become available in 2020, even if they are not available nationwide at that time.

**Question No. 48. What would be the most appropriate geographical area for frequency licences? Why?**

# Part 3. The 24.25 – 27.5 GHz band

## 3.1 Definition of the band

In its Opinion of 9 November 2016 on 5G frequencies, with an eye to pioneer use by 2020, the European Radio Spectrum Policy Group (RSPG) emphasises that it will be necessary to allocate frequencies above 24 GHz to guarantee that target 5G performance can be achieved, e.g. datarates of several gigabits per second. It recommends using the 26 GHz band (24.25 – 27.5 GHz) as the pioneer band. In addition, the CEPT published Decision ECC/DEC/(18)06[28] on 6 July 2017 which harmonises the 26 GHz band as follows:

- The frequency arrangement is a TDD arrangement with a block size of 200 MHz;
- This block size could be adjusted to narrower blocks (multiples of 50 MHz) adjacent to other users, to allow full use of spectrum, if required;
- If blocks need to be offset to accommodate other uses, this shift should be done in 10 MHz steps.


Figure 4 Harmonisation of the 26 GHz band

In December 2016, the European Commission entrusted the CEPT with the task of developing harmonised technical conditions for 26 GHz band spectrum, for the introduction of 5G. In July 2018, CEPT adopted the CEPT 68 report[29] proposing harmonised technical conditions for MFCN in the 26 GHz band, for 5G. Based on this report, work is currently underway by the Radio Spectrum Committee (RSCOM) with the aim of adopting a decision harmonising the 26 GHz band for 5G in 2019.

Meanwhile 3GPP[23] has defined the n258 band for 5G TDD use as follows:

| NR *operating band* | Uplink (UL) *operating band* BS receive/UE transmit $F_{UL\_low} – F_{UL\_high}$ | Downlink (DL) *operating band* BS transmit/UE receive $F_{DL\_low} – F_{DL\_high}$ | Duplex Mode |
|---|---|---|---|
| n258 | 24.25 – 27.5 GHz | 24.25 – 27.5 GHz | TDD |

Figure 5 Definition of the n258 band for 5G

The proposal in the European code is to have at least 1 GHz in this band allocated by 2020 at the latest[30].

[28] ECC/DEC/(18)06 "ECC Decision of 6 July 2018 on the harmonised technical conditions for Mobile/Fixed Communications Networks (MFCN) in the 24.25 – 27.5 GHz band" https://www.ecodocdb.dk/download/5e74d0b8-fbab/ECCDec1806.pdf

[29] https://www.ecodocdb.dk/download/647092ab-e807/ECPT%20Report%2068.pdf

[30] "By 31 December 2020 for terrestrial systems capable of providing wireless broadband electronic communications services, Member States shall, where necessary in order to facilitate the roll-out of 5G, take all appropriate measures to allow the use of at least 1 GHz of the 24.25 to 27.5 GHz frequency band, provided that there is a clear evidence of market demand and absence of significant constraints for migration of existing users or band clearance." https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CONSIL:ST_10692_2018_INIT&from=EN

In response to the public consultation titled "Outlook the introduction of 5G in the 26 GHz band"[31] that Arcep held from 22 May to 18 June 2018, certain players pointed out that compatible equipment and devices would be available in 2020 for the upper end of the 26.5 – 27.5 GHz band, which overlaps with the 3GPP n257 band (26.5 – 29.5 GHz).

**Question No. 49. What is your analysis of the 26 GHz band's virtues for the introduction of 5G? What is your assessment of how mature the ecosystem in the upper end of the band will be by 2020?**

## 3.2 The band's availability

Today, only the 26.5 – 27.5 GHz band (1 GHz) is available and can be allocated starting in 2020[32]. After that, the entirety of the band should gradually become available, keeping in mind that:

- First, a guard band will be required to protect the coexistence of earth observation satellites that use a band below 24.25 GHz, and which may suffer interference from 5G base stations and mobiles;
- Second, work is underway to assess the shared use of 26 GHz spectrum by 5G systems and satellite service earth stations in the 25.5 – 27 GHz band, to prevent a significant impact on coverage and 5G rollouts in this band.

Following the above-mentioned public consultation, which ran fro m 22 May to 18 June 2018, on the specific matter of efficient spectrum use and to ensure the frequencies are used properly, Arcep plans on issuing no new licences for radio relay systems in this band beyond 31 December 2023.

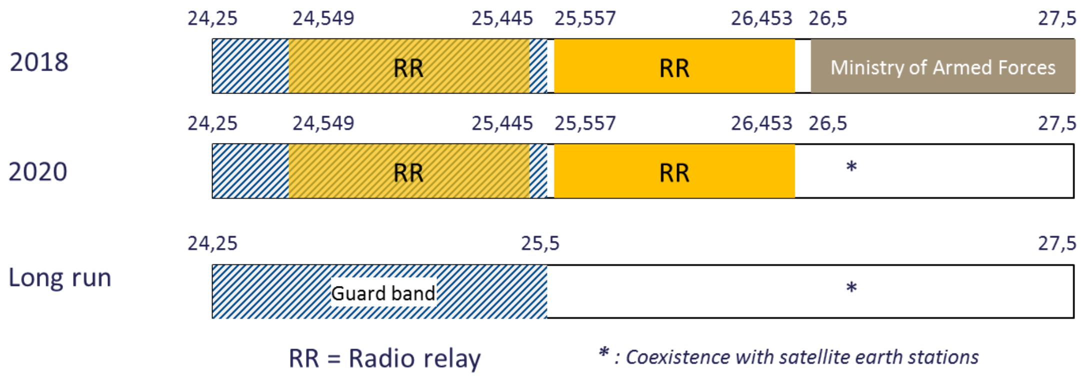



Figure 6. 24.25 – 27.5 GHz band occupancy

## 3.3 Coexistence of 24.25 – 27.5 GHz band allocations

Using the band in TDD mode requires coexistence techniques to be put into place to prevent interference between several users of the same band, especially since different technologies will potentially coexist in the band, at least temporarily.

[31] https://www.arcep.fr/uploads/tx_gspublication/synth-consult-frequences-5g-26_GHz-juil2018.pdf

[32] With the exception of several satellite service earth stations

### 3.3.1 Coexistence between 5G users

It emerged from the work done by CEPT that the most efficient solution for ensuring the coexistence of 5G networks in TDD mode in this frequency band appears to be frame synchronisation, or semi-synchronisation.

**Question No. 50. Are you in favour of implementing synchronisation, or a semi-synchronisation, between 5G TDD networks in this band? If so, why? If synchronisation were to be implemented, what do you think the right uplink/downlink time ratio would be? Do synchronisation parameters need to be stipulated in future licences, or defined in concert with the frequencies' licence-holders?**

### 3.3.2 Coexistence with the Earth exploration satellite service (EESS), earth stations, the Space research service (SRS) and fixed satellite services (FSS)

A small number of earth stations in the 25.5 – 27 GHz band is expected to coexist with 5G mobile networks deployed in these same bands. Work is underway to assess the shared use of 26 GHz spectrum between 5G systems and satellite service earth stations (present and future) in the 25.5 – 27 GHz band, to avoid a significant impact on 5G coverage and deployment in this band.

**Question No. 51. What do you think the criteria should be for assessing the impact that coexistence with earth stations will have on 5G performance? What constitutes a significant impact? What guard band or separation width will be needed to prevent interference?**

## 3.4 Allocation timetable

The band will become available in stages, with 1 GHz available by 2020, 2 GHz after the migration of radio-relay systems and, potentially, 3.25 GHz in the long run, when 5G radio equipment is capable of not causing interference with earth observation satellites.

**Question No. 52. Should the allocation of the 26.5 – 27.5 GHz band be carried out as part of the same procedure as the 3.4 – 3.8 GHz band? Same question for 25.5 – 26.5 GHz band? Same question for the 24.25 – 25.5 GHz band?**

In the event that the 25.5 – 26.5 GHz band is allocated after the 26.5 – 27.5 GHz band, to ensure efficient spectrum use, and due to the maximisation of channels resulting from the accumulation of frequencies allocated to the same licence-holder in the course of the two allocation procedures, a rearrangement of the band could be justified. The same could also apply once the entirety of the 24.25 – 27.5 GHz band is released and allocated.

**Question No. 53. Are there technical impediments to rearranging the 26 GHz band once the entire 3.25 GHz of the 26 GHz band have been allocated?**

## 3.5 Procedure for allocating the 24.25 – 27.5 GHz band

### 3.5.1 Quantity of frequencies

Because of the large quantity of frequencies available in this band – 1 GHz by 2020, 2 GHz later and potentially 3.25 GHz in the long run – it will, in theory, be easy to create very wide channel bandwidths, and much wider than 100 MHz. The band is identified as capable of achieving very fast uplink and downlink speeds, well above 1 Gbit/s, which other 5G pioneer frequency bands will not, *a priori*. This therefore raises the question of the quantity of frequencies that will be needed in this band to reap the full benefits of 5G.

The total amount of spectrum available in this band in 2020 will be limited, however.

Because of restrictions weighing on availability, and to ensure fair and equal access to the spectrum, provisions could be introduced that limit the ability to accumulate spectrum – i.e. a spectrum cap imposed on all of the candidates – during the procedure and during the life of the licences. Some countries have thus decided on a spectrum cap of 400 MHz during the procedure.

**Question No. 54. What do you believe is the minimum quantity of frequencies required? What would be the impact on 5G performances of having a channel of only 200 MHz in the band? Do you think a spectrum cap is needed for this procedure? For the life of the licences? If so, what cap do you think is appropriate?**

**Question No. 55. With 5G, will network equipment make it possible to aggregate several non-contiguous blocks of frequencies? What are the potential impediments to the channelling and channel spacing of non-contiguous blocks?**

### 3.5.2 Licensing regime and geographical area of the frequency licences

Because of their propagation properties, "millimetre wave" frequency bands have an only short range, and so small cells that do not exceed several hundred metres. This characteristic means a low risk of interference between sites if they are separated by a reasonable geographic distance. Moreover, a very large number of cells would be needed to provide continuous coverage in this frequency band, well above the current density of cell sites.

To ensure, in particular, efficient spectrum use and enable a more flexible 5G deployment in this frequency band, either in areas that are not necessarily covered by other 5G bands, or to provide a complement to other bands but for specific applications that require an ultrafast service over a small geographical area, different types of licence are possible.

The different authorisation regimes under which the 26 GHz band could be allocated would be:

- Either to use the band under a general authorisation regime, which means that an individual licence would not be required ahead of time, but its use could be subject to compliance with technical conditions. Note that CEPT work on harmonisation has not considered this option up to now. Additional work would therefore need to be done to put such an authorisation regime into place;
- Or to apply an individual licence regime.

A general authorisation regime allows for very dynamic and flexible use of the frequencies, but the lack of any guarantee of non-interference could be a serious drawback in those locations where several players want to deploy a 5G service with this frequency band.

If an individual licence regime is used, two geographical areas could be considered:

- Local. The size of the zone would need to be defined. It could range from a very finely meshed grid of the country (into grid squares of several dozen hectares each), on the scale of an administrative region. Should a very fine mesh be employed, and if there is no scarcity of spectrum resources, allocations could be performed over time, on the basis of requests for each square of the grid;

- National with, perhaps, the possibility to use blocks of 26 GHz band spectrum that were allocated to other licence-holders, provided there is no risk of interference, as described in section 1.4.9.

**Question No. 56. Should all or a part of the 26 GHz band be subject to an allocation, under a general authorisation regime for the deployment of 5G? Why? If so, what technical conditions would be appropriate and necessary to enable the use of these frequencies for 5G under such a regime?**

**Question No. 57. To what extent would it be advisable to have local allocations of the 26 GHz band under a general authorisation regime? What would be the most suitable geographical area?**

**Question No. 58. What are the pros and cons of having individual national licences for this frequency band?**

# Part 4. The 1427 – 1518 MHz band

## 4.1 Definition of the band

On 2 March 2018, CEPT adopted the revised Decision ECC/DEC/(13)03[33] which harmonises the 1452 – 1492 MHz band as follows:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1452 -1457 | 1457-1462 | 1462-1467 | 1467-1472 | 1472-1477 | 1477-1482 | 1482-1487 | 1487-1492 |
| **Downlink (base station transmit)** | | | | | | | |
| 40 MHz (8 blocks of 5 MHz) | | | | | | | |

Figure 7 Harmonisation of the 1452 – 1492 MHz band

Based on the CEPT 65 report[34], the European Commission adopted Decision 2018/661 of 26 April 2018 amending Decision 2015/750 which harmonises the entire 1427 – 1518 MHz band for use in SDL mode.

| | | | | | |
|---|---|---|---|---|---|
| 1427-1432 | 1432-1437 | 1437-1442 | 1442-1447 | 1447-1452 | |
| **Downlink (base station transmit)** | | | | | |
| 25 MHz (5 blocks of 5 MHz) | | | | | |
| 1492-1497 | 1497-1502 | 1502-1507 | 1507-1512 | 1512-1517 | 1517-1518 |
| **Downlink (base station transmit)** | | | | | **Guard band** |
| 25 MHz (5 blocks of 5 MHz) | | | | | 1 MHz |

Figure 8 Harmonisation of the 1427 – 1452 MHz band and of the 1492 – 1518 MHz band

The entire band is thus harmonised as follows:

**1427 MHz** **1518 MHz**

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1427 - 1432 | 1432 - 1437 | 1437 - 1442 | 1442 - 1447 | 1447 - 1452 | 1452 - 1457 | 1457 - 1462 | 1462 - 1467 | 1467 - 1472 | 1472 - 1477 | 1477 - 1482 | 1482 - 1487 | 1487 - 1492 | 1492 - 1497 | 1497 - 1502 | 1502 - 1507 | 1507 - 1512 | 1512 - 1517 | 1517 - 1518 |
| **Downlink (base station transmit)** | | | | | | | | | | | | | | | | | | **Guard band** |
| 90 MHz (18 blocks of 5 MHz) | | | | | | | | | | | | | | | | | | 1 MHz |

Figure 9 Harmonisation of the 1427 – 1518 MHz band

[33] ECC/DEC/(13)03 "ECC Decision of 3 July 2015 on the harmonised use of the frequency band 1452 – 1492 MHz for Mobile/Fixed Communications Networks Supplemental Downlink (MFCN SDL)"
https://www.ecodocdb.dk/download/ccf1bd32-f898/ECCDec1303.pdf

[34] CEPT report 65 "Report from CEPT to the European Commission in response to the Mandate "to develop harmonised technical conditions in additional frequency bands in the 1.5 GHz range for their use for terrestrial wireless broadband electronic communications services in the Union" https://www.ecodocdb.dk/download/2a279732-4ab1/ECPTRep065.pdf

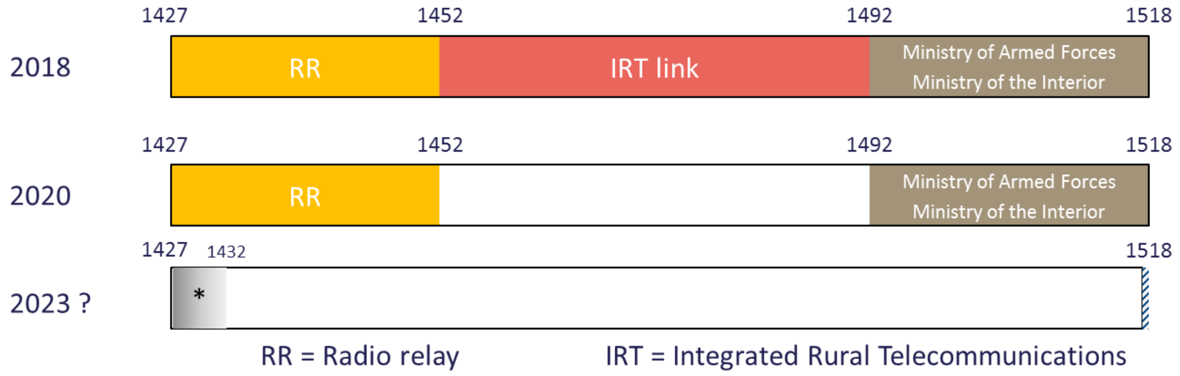
Meanwhile 3GPP[23] defined the b32, b75 and b76 bands for 4G SDL use and the n75 and n76 bands for 5G SDL use as follows:

| NR *operating band* | Uplink (UL) *operating band* BS receive/UE transmit $F_{UL\_low} - F_{UL\_high}$ | Downlink (DL) *operating band* BS transmit/UE receive $F_{DL\_low} - F_{DL\_high}$ | Duplex Mode |
|---|---|---|---|
| b32 | N.A. | 1452 – 1496 MHz | SDL |
| b75/n75 | N.A. | 1432 – 1518 MHz | SDL |
| b76/n76 | N.A. | 1427 – 1432 MHz | SDL |

Figure 10 Definition the b32, b75/n75 and b76/n76 bands for 4G/5G

## 4.2 The band's availability

Today, only 40 MHz in the 1452 – 1492 MHz band are expected to be available in 2020. Work is underway to set a timetable for migrating radio relay systems using the 1427 – 1452 MHz band, and to release the 1492 – 1517 MHz band assigned to the Ministry of the Armed Forces.




* *Low-power base station (protection of the earth observation satellite and radio astronomy service)*

Figure 11. 1427 – 1518 MHz band occupancy

## 4.3 Allocation timetable

Because the frequency band has already been harmonised, and even though its use in the short term will likely be for 4G and not 5G, there are nevertheless plans to allocate this band at the same time as the 3.5 GHz and 26 GHz bands.

In addition, because the band will not be fully available before 2023, and possibly 2026, the question arises of whether to allocate the band in two stages:

- allocation of the 1452 – 1492 MHz band in the first stage;
- allocation of the 1427 – 1442 MHz and 1492 – 1517 MHz bands in the second stage.

**Question No. 59. Should the 1452 – 1492 MHz band be allocated at the same time as the 3.5 GHz band? Should the remainder of the band be allocated at the same time as the 1452 – 1492 MHz band, or at a later date?**

## 4.4 Procedure for allocating the 1427 – 1517 MHz band

This frequency band could be allocated in 10 blocks, as follows:

| 1427 MHz | 1432 MHz | 1442 MHz | 1452 MHz | 1462 MHz | 1472 MHz | 1482 MHz | 1492 MHz | 1502 MHz | 1512 MHz |
|---|---|---|---|---|---|---|---|---|---|
| Bloc 1 | Bloc 2 | Bloc 3 | Bloc 4 | Bloc 5 | Bloc 6 | Bloc 7 | Bloc 8 | Bloc 9 | Bloc 10 |
| 5 MHz | 10 MHz | 10 MHz | 10 MHz | 10 MHz | 10 MHz | 10 MHz | 10 MHz | 10 MHz | 5 MHz |
| 1427 MHz | | | | | | | | | 1517 MHz |

Figure 12. 1427 – 1517 MHz frequency band arrangement

Blocks 1 and 10 would be “specific” blocks with a set position.

Blocks 2 to 9 would be “generic” blocks, whose positions would be determined by a subsequent arrangement procedure.

**Question No. 60. Do you believe the channel arrangement proposed for the allocation is suitable? If not, why not?**

**Question No. 61. Do you think it would be pertinent to set a spectrum cap for the procedure? For the life of the licences? If so, what would be the appropriate cap?**

## The questions