DIGITALEUROPE

DIGITALEUROPE
5G SPECTRUM OPTIONS FOR EUROPE

October 2017

DIGITALEUROPE
Rue de la Science, 14 - 1040 Brussels [Belgium]
T. +32 (0) 2 609 53 10 F. +32 (0) 2 431 04 89
www.digitaleurope.org | info@digitaleurope.org | @DIGITALEUROPE
Transparency register member for the Commission: 64270747023-20

Table of Contents

1. INTRODUCTION 3
2. ITU-R ACTIVITIES: AGENDA ITEM 1.13 FOR WRC-19 4
A. SPECTRUM NEEDS STUDIES 4
B. SHARING AND COMPATIBILITY STUDIES 5
C. IMT-2020 DEVELOPMENT 5
3. 3GPP 6
4. COUNTRY AND REGIONAL INITIATIVES FOR 5G SPECTRUM OUTSIDE OF EUROPE 9
5. DEVELOPMENT OF 5G SPECTRUM IN EUROPE 13
6. TEST BEDS AND TRIALS 16
7. PRODUCT AVAILABILITY 20
8. LICENSING OF 5G SPECTRUM 23
9. RECOMMENDATIONS ON 5G SPECTRUM FOR EUROPE 25
10. LIST OF ACRONYMS AND ABBREVIATIONS 27

DIGITALEUROPE
Rue de la Science, 14 - 1040 Brussels [Belgium]
T. +32 (0) 2 609 53 10 F. +32 (0) 2 431 04 89
www.digitaleurope.org | info@digitaleurope.org | @DIGITALEUROPE
Transparency register member for the Commission: 64270747023-20

1. Introduction

The capabilities of next generation of wireless networks will make possible massive new levels of connectivity, tremendous throughput speed and high reliability mobile communications. These capabilities will be met through the development of new air interfaces, new networking technologies as well as the evolution and enhancement of today's technology. 5G is thus more than a gradual evolution of current mobile broadband: it is a trigger for deep social, business, and industrial transformation that will impact numerous vertical markets: automotive, energy, agriculture, city management, government, healthcare, manufacturing, public transportation, etc.

Technology developments to meet these capabilities will be deployed in the existing frequency bands identified for mobile communications but they will also require new spectrum resources to specifically provide high bandwidth resources that can efficiently deliver high throughput services.

The ITU-R considers the spectrum for public wireless networks (3G, 4G and now 5G) under the IMT framework. At the ITU-R World Radiocommunications Conference 2015 an Agenda Item for WRC-19 (AI 1.13) for studying 5G spectrum was agreed. A number of frequency bands between 24.25 GHz and 86 GHz will be studied until WRC-19, where a decision on allocations for the Mobile Service and/or Identifications for IMT will be taken. In the study period between WRC-15 and WRC-19 the new spectrum needs for IMT will be analysed, as well as compatibility with other services.

In parallel, there are country and regional initiatives to specify new frequency bands for commercial use or test systems, such as the Rulemaking in the US, the activities towards the Olympic Games in Korea and Japan and the definition of pioneer bands in Europe. These initiatives are addressing higher frequency bands that will assist to meet the very high throughput capabilities of 5G networks, but also bands below 6 GHz that could provide a combination of high bitrates and good coverage. Some of the bands under consideration are not on the ITU-R list for WRC-19. In addition, there are test systems planned or already up and running in a number of locations and for various frequency bands in different countries.

Work in 3GPP is also progressing, and has indeed been accelerated to provide timely specifications for 5G New Radio (NR). In addition, vendors are already developing commercial equipment that will meet the requirements for early deployments in Europe and in other parts of the World.

Discussions have started in Europe regarding the appropriate licensing methods of 5G spectrum, e.g. in the context of public consultations in different countries and the second opinion on 5G spectrum from RSPG. Aspects such as harmonisation of licensing conditions, license duration, licensed vs license exempt etc. will greatly influence the willingness to invest in spectrum, and thus the success of 5G in Europe. Methods for making spectrum available for verticals also needs to be considered.

These different activities need to be taken into consideration already now in the development strategies for 5G spectrum in Europe, in order to achieve maximum possible harmonization and for Europe to influence and keep pace with international developments. DIGITALEUROPE thus provides recommendations on the way forward regarding 5G spectrum for Europe.

2. ITU-R Activities: Agenda Item 1.13 for WRC-19

Table 1 details the frequency bands identified in ITU-R Resolution 238 (WRC-15) that will be studied in preparation for agenda item 1.13 of WRC-19 (ITU-R Resolution 809 (WRC-15)). The agenda item will consider identifying new bands for the new generation of mobile communications commonly referred to as 5G[1]. The bands are in the frequency range 24.25 – 86 GHz and comprise a total bandwidth of about 32 GHz. It is not expected that all of these bands will be identified for or used by 5G.

In addition, ITU-R Resolution 238 invites studies into the spectrum needs for 5G across the same frequency range.

The selection of bands will depend on the results of the studies called for by ITU-R Resolution 238 and certain frequency ranges may also become more or less prominent driven by regional considerations and industrial developments.

30 GHz	24.25-27.5 GHz, 31.8-33.4* GHz
40 – 55 GHz	37-40.5,40.5-42.5*,42.5-43.5 GHz, 45.5-47 GHz, 47-47.2*, 47.2-50.2 GHz, 50.4-52.6 GHz
66 – 86 GHz	66-71 GHz, 71-76 GHz, 81-86 GHz

Table 1. Frequency bands for study under ITU-R Resolution 238. Frequency bands marked with an asterisk do not have a primary mobile allocation in the Radio Regulations. 24.25 – 25.25 GHz does not have a primary mobile allocation in Regions 1 or 2, only in Region 3.

a. Spectrum Needs Studies

The studies are directed to take into account the technological advances expected for 5G and particularly the related requirements of high data traffic such as in dense urban areas and/or in peak times. The results of the studies have now been contributed to the preparatory work for WRC-19 Agenda Item 1.13 within the ITU-R.

Determining the spectrum needs for 5G (or any technology) requires several assumptions about the technology performance, the expected market and services, and the deployment characteristics. For these reasons several approaches were considered by the ITU-R expert group. An "Application based" approach considers at a high level the need to deliver high data rate applications into a population of devices. A Technical performance-based approach considers in more detail the performance of the radio equipment and network deployment and alternatively the impact of fulfilling the 5G Technical Performance Requirements were considered.

In addition, some countries carried out their own assessments of the spectrum needs based on national circumstances and these were taken into account too.

According to the application based approach, 2-3 GHz for the lower ranges below 33.4 GHz is required rising to 6 to 9GHz for the high frequencies above 66 GHz. The estimates cover urban and dense urban scenarios as well as

[1] Formally in the ITU-R, mobile communications standards families and spectrum are brought together under the International Mobile Telephony (IMT) umbrella. IMT-2020 is the new addition to the family that encompasses the capabilities of future 5G systems.

very high traffic hot spots such as arena events. The technical performance based approach in similar scenarios estimates 5.8-7.7 GHz in bands below 43.5 GHz.

Some specific country analyses indicate requirements for 2-6 GHz in the ranges below 43.5 GHz.

b. Sharing and Compatibility Studies

Within the ITU-R a specific Task Group[2] has been formally established with the task of documenting the study work requested under ITU-R Resolution 238 in preparation for the WRC-19. This activity is supplemented by regional activities developing the technical studies between the anticipated 5G systems and the incumbent services in the frequency ranges under study. The incumbent services are frequency band dependant and include a number of space borne and terrestrial applications. So far the largest number of contributions to ITU-R TG 5/1 have been for the 26 GHz band. The study work continues at a pace and within Europe the Conference Preparatory Group (CPG) is developing technical studies relevant to the European situation.

c. IMT-2020 Development

Having a globally harmonised framework for future 5G technologies and deployments brings benefits for industry, governments and consumers. In recognition of this (as for previous generations) the ITU-R has embarked on the IMT-2020 programme[3] of technology evaluation and consensus building towards the finalisation of IMT-2020 standards during 2020. The process invites contributions from the various regional standards setting organisations and subjects the technology proposals to an evaluation procedure based on agreed criteria. The standardised proposals that meet the criteria become part of the IMT-2020 family which is published as a whole in a final ITU-R Recommendation.

The figure below illustrates the timeline for this work in ITU-R:

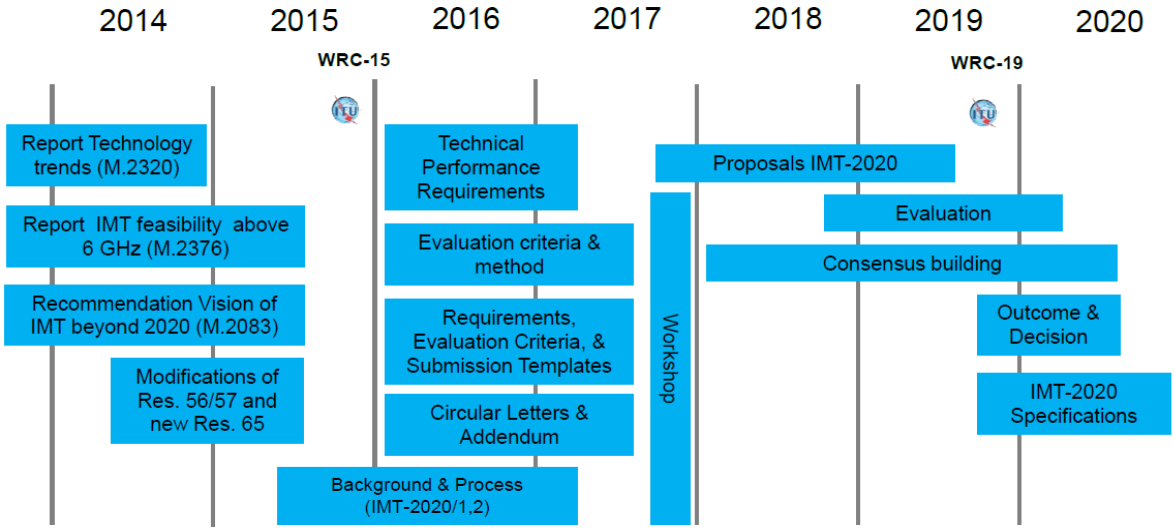

Figure 1: ITU-R timeline

[2] Task Group TG5/1

[3] http://www.itu.int/en/ITU-R/study-groups/rsg5/rwp5d/imt-2020/Pages/default.aspx

3. 3GPP

At its March plenary meeting, 3GPP agreed to a work plan proposal (RP-170741) for the first 3GPP 5G New Radio (NR) specification that will be part of Release 15 – the global 5G standard. As part of this work plan, a wide number of mobile industry leaders committed to accelerate the 5G NR schedule by introducing an intermediate milestone for an early completion of a variant called Non-Standalone (NSA) 5G NR. This intermediate milestone will enable 3GPP-based large-scale trials and standard-compliant deployments as early as 2019, instead of in 2020 as planned earlier.

- Non-Standalone (NSA) 5G NR will utilize the existing LTE radio and core network as an anchor for mobility management and coverage while adding a new 5G carrier. This is the configuration that will be the target of early 2019 deployments (in 3GPP terminology, this is NSA 5G NR deployment scenario Option 3).
- Standalone (SA) 5G NR implies full user and control plane capability for 5G NR, utilizing the new 5G core network architecture also being done in 3GPP.

With the recently agreed upon proposal, it is defined a framework to ensure commonality between these two variants, as well as making forward compatibility a key design principle for the standardization of the first release of 5G NR. This will enable in-band introduction of new capabilities and features in subsequent releases of the standard, such as the addition of new signals to support new industries or use cases to achieve the 5G vision to connect everything to everything. An overview of the 3GPP 5G NR Release 15 work plan and schedule can be seen below; the complete details can be found in RP-170741.

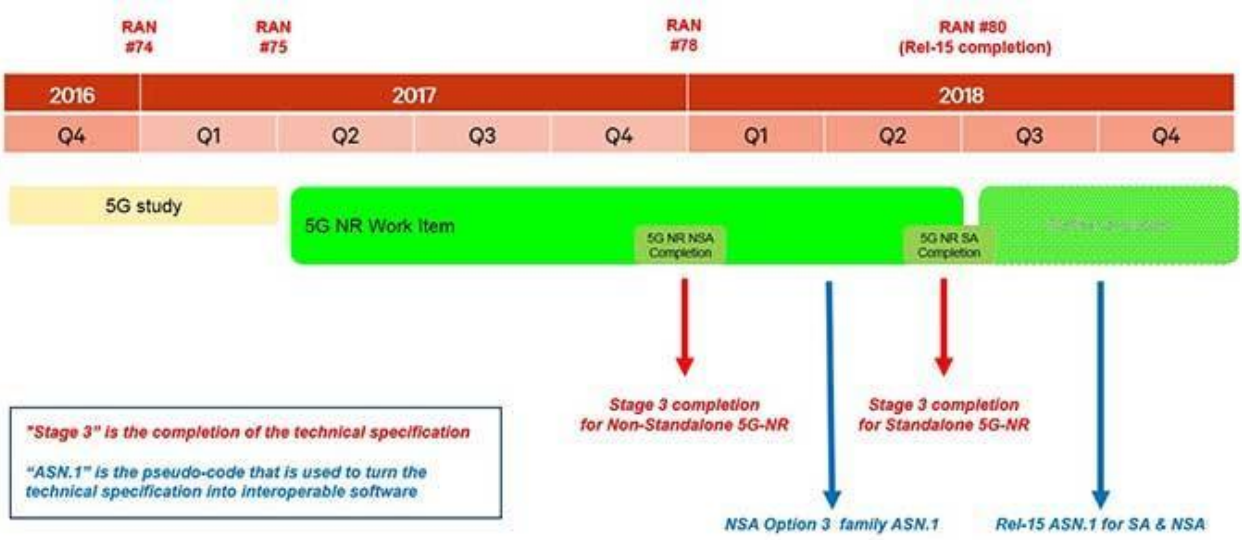

Figure 2: 3GPP work plan for 5G NR Release 15

5G NR deployments in 2019 will require more than just R&D test beds and a 3GPP specification. For example, it will require over-the-air trials and interoperability testing, compliant with the 3GPP 5G NR specification, to test and simulate 5G NR technologies in real-world scenarios across a broad set of use cases and deployment scenarios. In addition, an accelerated timeline for 5G NR deployments would be incomplete without supporting

devices. This is why mobile industry is working hard to provide equipment, devices and chipsets as early as 2018 (see section on equipment availability).

Work has also started in 3GPP for the specification of the 5G-NR[4][5] bands. The standardization of the first new 5G-NR bands is expected to reach completion by June 2018, within the 3GPP release 15.

For the bands below 6 GHz, 3GPP is particularly focused on the C-band: it will address the larger 3300-4200 MHz range within Release 15.[6] As illustrated in the diagram below, such a larger range could be technically implemented at the User Equipment (UE) side with two radio chains addressing, for example, the 3300-3800 MHz and the 3600-4200 MHz portions respectively. The following options are being discussed in 3GPP[7]:

- Specify two different bands with the indication that 'a UE supporting Band X shall also support Band Y and vice versa' (Band n78/Band X: 3300-3800 MHz; Band Y: 3600-4200 MHz)
- Specify 3300-4200 GHz as a single band
- Specify both of the above options, i.e. definition of 3 new bands

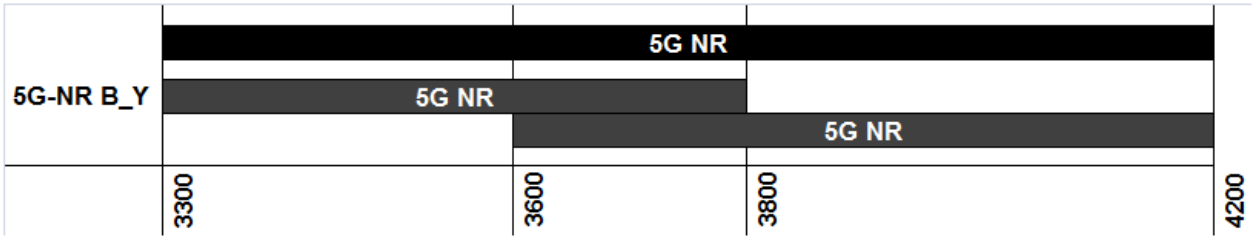

Figure 3: 3GPP channel arrangements for 5G-NR

There are several new strands of work in 3GPP aimed at enabling the deployment of 5G-NR networks in the existing mobile bands used by LTE. In particular,, 3GPP is working on the mechanisms which would allow efficient co-existence of LTE and 5G-NR in the same frequency band and enhance the flexibility of spectrum use.

It is also working on the so called "UL pairing" option (low-band/high-band combinations) where the available lower frequencies (e.g. 1800, 800, 900, 700 MHz) may be used in combination with higher frequency bands (e.g. 3300-4200 MHz, 26-28GHz, 39GHz) 5G-NR connectivity to provide additional efficiency and/or coverage improvement, facilitating the reuse of existing sites.

Such a solution would enable 5G-NR in the C-band to be co-sited with LTE deployed in a lower band and would increase spectral efficiency, user data rates and/or extend the coverage of 5G-NR. The figure below shows the idea of such a solution.

4 RP-170847, 'New WID on New Radio Access Technology', March 2017.

5 TR38.802 V14.0.0, 3GPP 'Technical Report: Study on New Radio Access Technology, Physical Layer Aspects' (Release 14), March 2017.

6 3.3-4.2 GHz, 4.4-4.99 GHz, 24.25-29.5 GHz, 31.8-33.4 GHz, 37-40 GHz, 1.427-1.518 GHz, Band 3, Band 7, Band 8, Band 20, Band 28, Band 41, Band 66, Band 1 (Ref.: 3GPP RP-170855).

7 R4-1704410

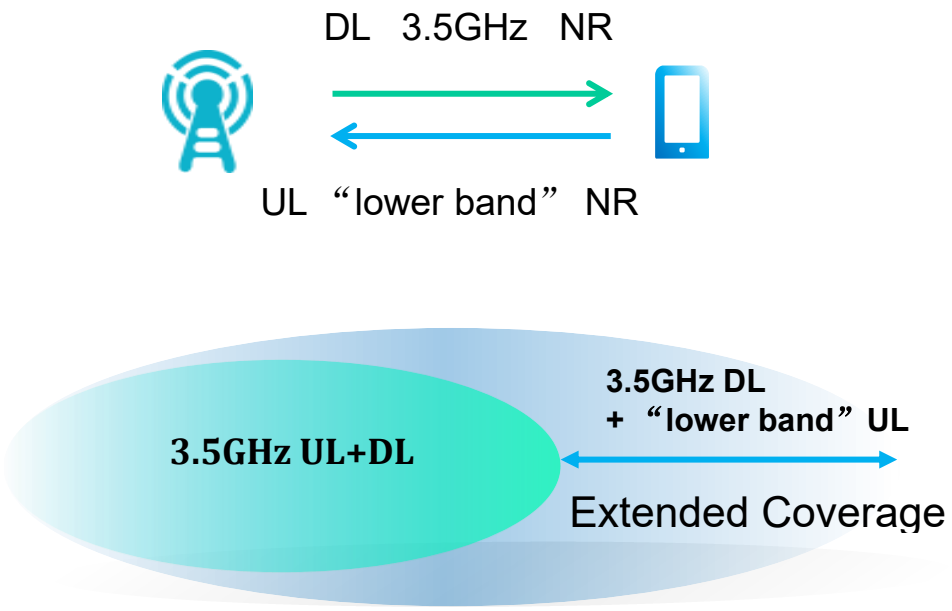

Figure 4: An example solution of extending 5G-NR coverage by combining C-band and a lower band.

Significant work is also ongoing on the 26 GHz band. Two bands will be defined for 5G NR in 24.25-29.5 GHz frequency range: 24.25-27.5 and 26.5-29.5 GHz with the target for completion by December 2017 and the latest by June 2018 during Release 15.

4. Country and Regional Initiatives for 5G Spectrum Outside of Europe

A number of country and regional initiatives have been taken for 5G spectrum, both for commercial deployments and test beds. In some cases, local spectrum needs have a different timing than that of the ITU-R process, in other cases particular frequency bands not on the ITU-R list for WRC-19 have been identified as providing good 5G opportunities locally. In addition, bands that already have IMT identifications, below 6 GHz, may be used for 5G deployments. The requirement for early access to 5G frequency bands in the US, Korea, China and Japan is of great importance for the development of the first 5G capable infrastructure and devices.

USA

5G deployments in the US will utilize all spectrum bands — from low bands such as 600 MHz, to mid bands such as spectrum around 3.5 GHz, to high bands such as 28 GHz, 39 GHz, and other millimetre wave bands.

In April of this year, the FCC announced the results of its very successful auction of 600 MHz spectrum — prime, low-band spectrum that will bring greater capacity and improved coverage for mobile broadband. The auction generated more than $19.8 billion in proceeds, and it will open 70 MHz of licensed spectrum for fast mobile broadband. This spectrum is especially valuable for Gigabit LTE as well as 5G. It is suited for long-range, macro deployments that are not only great for providing enhanced mobile broadband coverage over a large area, but also ultimately connecting the wide-area massive Internet of Things and more.

The 3.5 GHz band in the US is another candidate for 5G deployments. The FCC begun the process of approving the Spectrum Access System and Environmental Sensing Capabilities that need to be in place before 3.5 GHz mobile operations can commence under the CBRS sharing mechanism. This process (which involves the development of additional spectrum access guidelines that industry is working on) can take an additional 2-3 years, which makes this band another candidate for 5G mobile operations.

Furthermore, in August 2017, the FCC published a Notice of Inquiry seeking input on potential opportunities for additional flexible access—particularly for wireless broadband services—in spectrum bands between 3.7 and 24 GHz (mid band spectrum). In particular, FCC is seeking detailed comment on three specific bands: 3.7-4.2 GHz; 5.925-6.425 GHz; and 6.425-7.125 GHz.

In the high-band, about 11 GHz of spectrum (28 GHz and 37-40 GHz for licensed, and 64-71 GHz for license exempt) has been made available for mmWave applications, with additional candidate bands identified for IMT-2020: the "Spectrum Frontiers" Rulemaking proposes that the four-millimetre wave bands in Table 2 (New Rules Adopted) should be made available for 5G usage in the US, while it considers additional bands (Future Consideration).

The FCC has published a REPORT AND ORDER AND FURTHER NOTICE OF PROPOSED RULEMAKING[8] adopting the rules authorizing mobile operation in the four-millimetre wave bands. In addition, in the US there is the Mobile Now Act[9], a proposal for a bill where a number of bands are proposed for further studies.

US Regulatory Consideration	Bands Considered	
	New Rules Adopted	Future Consideration

[8] https://www.fcc.gov/document/fcc-adopts-rules-facilitate-next-generation-wireless-technologies

[9] Bill S.2555, Making Opportunities for Broadband Investment and Limiting Excessive and Needless Obstacles to Wireless Act or the MOBILE NOW Act, Introduced 2/11/16, https://www.congress.gov/bill/114th-congress/senate-bill/2555?q=%7B%22search%22%3A%5B%22mobile+now%22%5D%7D&resultIndex=1

FCC Spectrum Frontiers Rulemaking	27.5-28.35 GHz 37-38.6 GHz 38.6-40 GHz 64-71 GHz (license exempt)	24.25-24.45 GHz 24.75-25.25 GHz	31.8-33 GHz 42-42.5 GHz 47.2-50.2 GHz 50.4-52.6 GHz 71-76 GHz 81-86 GHz Above 95 GHz
Mobile Now Act	3100-3550 MHz 3700-4200 MHz 24.25-24.45 GHz 25.05-25.25 GHz 31.8-33.4 GHz 71-76 GHz 81-86 GHz		

Table 2: US Bands

Furthermore, in 2017 Verizon announced[10] the acquisition of Straight Path Communications, major holder of 5G spectrum licenses in the 28 GHz and 39 GHz frequency bands. The race for 5G airwaves in the US has been well described in the table below:

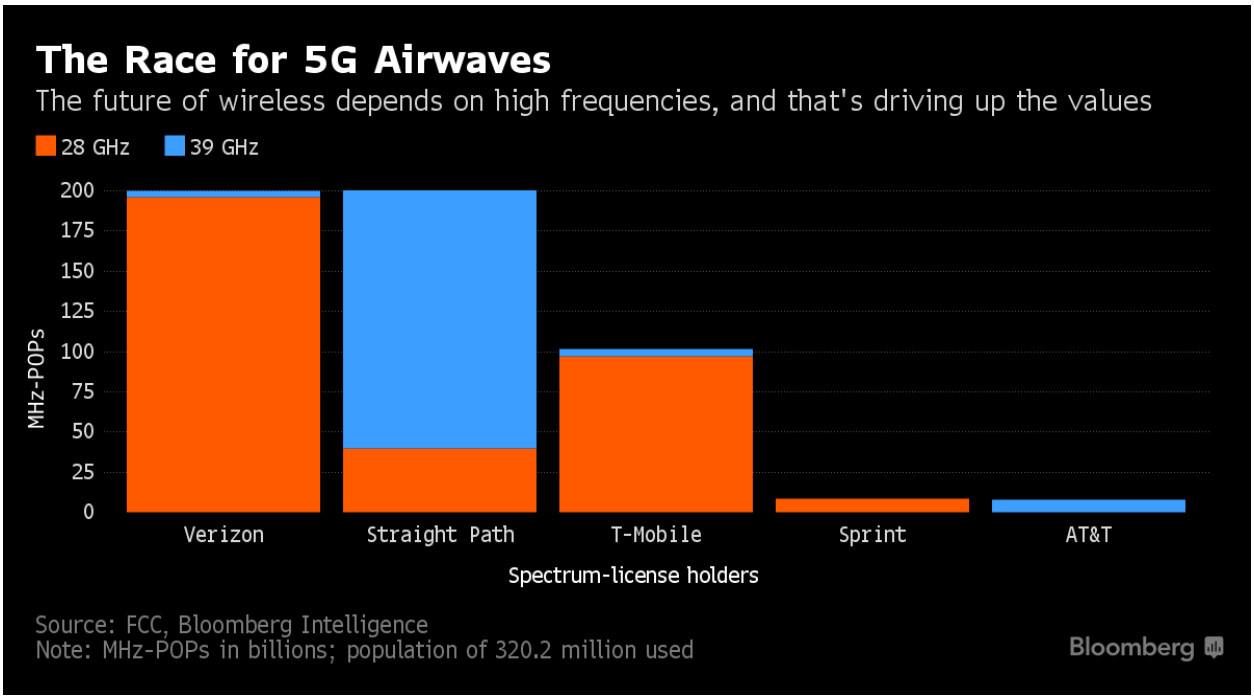

Figure 5: Spectrum License Holders (source: FCC/Bloomberg)

[10] https://www.wsj.com/articles/verizon-wins-bidding-war-for-straight-path-communications-sources-say-1494470230# =

Korea

Korean regulators are planning to allocate a total of 4 GHz of millimetre wave spectrum for 5G in three phases. The first phase will begin in 2018, focusing on millimetre wave in 27.5 – 28.5 GHz as well as mid-band in 3.4 – 3.7 GHz. Phase two will add 2 GHz of bandwidth in the 26.5 – 27.5 GHz and 28.5 – 29.5 GHz ranges but these could be allocated also in 2018 if the 5G eco-systems become available. The third phase will add an additional 1 GHz of bandwidth in the 2021 to 2026 timeframe, for a total 5G mmWave bandwidth of 4 GHz.

Spectrum around 28 GHz (26.5-29.5 GHz) has been identified for a 5G trial service at the 2018 Winter Olympics. Three operators in Korea have been allocated 1 GHz each in this range for the purposes of the trial.

China

China Academy of Information and Communication Technology has announced the ongoing 5G technology trial in the 3400-3600 MHz band. Operators are considering different parts of C-band (3300-3600 MHz, 4800-5000 MHz) for 5G.

The Chinese led IMT-2020 Promotion Group (IMT-2020PG) is carrying out a multi-annual trial programme to promote the development of 5G technology and systems in the higher frequency bands with a first technology trial phase progressing until the end of 2018. The trial partners are drawn from the entire supply chain including global chipset vendors, infrastructure and device vendors, operators and instrumentation suppliers. Phase 2 will move into product R&D trials until 2020.

The Chinese Ministry of Industry and Information Technology (MIIT) has recently consulted on the draft IMT-2020/5G spectrum regulation for 3300-3600 MHz and 4800-5000 MHz bands. The draft regulation states that these two bands are designated for IMT-2020 and MIIT plans to assign them to the operators as the next step. The regulation also provides general conditions for protection of the incumbent users in these bands.

As regards the mm-Wave bands, MIIT has recently consulted on the possible use of the 24.75-27.5 GHz and 37-42 GHz bands for IMT-2020/5G. The final decision on the designation of specific mmWave bands for IMT-2020/5G is yet to be taken by MIIT.

MIIT has issued a draft revision of the National Frequency Allocation Table which has been on public consultation. The major modifications proposed for IMT are as follows:

- 3300-3400 MHz: the use of mobile service in this band is for IMT, primarily for indoor use (note that designation of 3400-3600 MHz for IMT was already in the Table).
- 4400-4500 MHz: the mobile service in this band can be used for IMT. IMT system shall not cause harmful interference to aeronautical radio navigation stations in 4200-4400 MHz. This band shall not be used for IMT until the compatibility coexistence conditions are completed.
- 4800-5000 MHz: the use of mobile service in this band is for IMT.

Japan

Aiming for international harmonization, Japan has also been investigating the promising bands for 5G including 3600-4200 MHz, 4400-4900 MHz and 28GHz, in the Radio-policy 2020 established recently.

On May 16th, 2017 the Japanese Ministry of Internal Affairs and Communications (MIC) announced the start of 5G field trials in Japan using the 3600-4200 MHz, 4400-4900 MHz and 27.5-29.5 GHz bands. Major mobile operators and national research institutes selected by MIC will carry out 5G field trial for six different use cases.

In July 2017, MIC officially identified and issued a public consultation concerning 5G spectrum identifying up to 500 MHz of sub-6 GHz spectrum, to come from the 3.6-4.2 GHz and 4.4-4.9 GHz ranges, and up to 2 GHz of millimetre wave spectrum, to come from the 27.5-29.5 GHz range. MIC plans to issue the final technical rules, including the precise frequencies, by summer 2018.

Australia

Both mid-band spectrum in the 3.4-3.7 GHz range and millimetre wave spectrum are being targeted in Australia for 5G deployments. For millimetre wave, Australian operator Telstra has already announced trials in 2018 at the Commonwealth Games, using 28 and 39 GHz.

Singapore

In May 2017, IMDA (Infocomm Media Development Authority) issued a public consultation on spectrum for 5G. The consultation sought comment on a number of spectrum bands below 1 GHz, between 1 and 6 GHz, and above 6 GHz, including the 26 GHz and 28 GHz bands.

Hong Kong

In March 2017, the Communications Authority of Hong Kong issued a work plan on spectrum for 5G. The plan included allocation of low band (sub-1 GHz), mid-band (3.4-3.7 GHz) and millimetre wave (24.25-28.35 GHz) spectrum.

5. Development of 5G Spectrum in Europe

In 2016, the European Commission (EC) published its Action Plan that targets a Gigabit Society with the start of 5G trials from 2017, the launch of early 5G networks by 2018 followed by commercial 5G services in at least one major city in each Member State by 2020 and full 5G deployment across the EU by 2025. Pioneer spectrum bands have also been identified as part of this initiative in the three ranges of the spectrum: below 1 GHz (700MHz), between 1 GHz and 6 GHz (3.4-3.8 GHz), and above 6 GHz (26 GHz).

European regulatory bodies are working fast on harmonizing the 3.4-3.8 GHz and 26 GHz ranges. In parallel, spectrum awards are under planning in several Member States for both the 3.4-3.8 GHz and 26 GHz bands and expected in the 2017/2018 timeframe. The overall goal is to provide a regulatory framework to incentivize operator investments into 5G and the Gigabit Society, introducing regulatory measures allowing operators to fully take advantage of larger allocations of contiguous spectrum to increase peak rates and improve the user experience, with manageable terminal complexity and minimal power consumption.

RSPG Opinions

In November 2016, The Radio Spectrum Policy Group (RSPG) recommended the 700MHz, the 3.4-3.8 GHz and the 24.25-27.5 GHz as pioneer bands to enable 5G in Europe by 2020. In addition, RSPG has also established a Working Group on Spectrum related aspects for next-generation wireless systems (5G).

A Draft Supplementary Opinion is expected to be published by the end of 2017. Amongst other matters, this second opinion is expected to deal with 5G spectrum related challenges such as spectrum sharing, usage and license conditions, rural areas, policy implementation, incentive regulation, the principle of technology and service neutrality and the reuse of already harmonised spectrum to support the transition towards 5G.

700 MHz regulation and implementation

The 700 MHz band is harmonized in Europe by ECC Decision (15)01 (so far implemented by 13 countries, latest implementation status can be checked here) and COMMISSION IMPLEMENTING DECISION (EU) 2016/687 (28 April 2016). Additionally, the Decision (EU) 2017/899 of the European Parliament and of the Council of 17 May 2017 on the use of the 470-790 MHz frequency band in the Union states that Member States must reassign the 700 MHz band to wireless broadband services under harmonised technical conditions by 30 June 2020 (justified delays are allowed for up to 2 years).

Licensing actions are committed, completed, underway or planned in many countries including Austria, Finland, France, Germany, Iceland, Slovenia and UK. The MFCN frequency arrangement in the band 694-790 MHz includes a paired frequency arrangement (FDD 2x30 MHz, 703 – 733 MHz for UL and 758 – 788 MHz for DL)) and an optional unpaired frequency arrangement (SDL) consisting of one to four 5 MHz blocks.

Alternatively, the Decisions provide national options for the duplex gap such as PPDR, PMSE and M2M. The 700 MHz band provides a unique opportunity for delivering MBB and IoT services with very good rural and in-building coverage, and is in addition the fastest developing sub-1 GHz frequency band in the world, providing an excellent eco-system. DIGITALEUROPE strongly favours early implementation of the 700 MHz band in Europe, and the implementation of SDL in the duplex gap to provide additional downlink capacity.

3400-3800/4200 MHz regulation and implementation

Following the RSPG's first opinion identifying the above-mentioned bands, the Radio Spectrum Committee (RSC) agreed a Commission mandate to CEPT to develop harmonised technical conditions for 5G terrestrial systems for spectrum in 3.4-3.8 GHz and 26 GHz in support of the introduction of 5G in the European Union. The mandate asks CEPT to review the harmonized technical conditions applicable to the 3.4-3.8 GHz frequency band with view to their suitability for 5G, and if necessary to amend these conditions. The CEPT is thus now working on revising

the existing harmonized technical conditions for 3.4-3.8 GHz, to ensure their suitability for 5G. The work will be completed by June 2018 while stable results are expected during 2017.

At the member state level in Europe, the UK, Germany, France, Spain, Italy have recently signalled in their public consultation their willingness to auction this spectrum for 5G in the 2017/2018 timeframe. Regulatory efforts are aimed at reducing fragmentation in the 3.4-3.8 GHz range and give operators the possibility to purchase contiguous blocks of 100 MHz of spectrum – necessary to develop the MBB services using the 5G technology.

In the UK, OFCOM has announced its intention to auction 150 MHz in the 3.4-3.6 GHz spectrum in 2017 and additional 116 MHz in 2018/2019 timeframe, ARCEP in France has announced that it will make available 340 MHz of spectrum in the 3.4-3.8 GHz band in 2018. In Germany, BNetzA has highlighted its intention to proceed with an auction of 300 MHz of spectrum for 5G in 2018 and in Spain, the regulator has provided information on their re-farming activity regarding the 3.6-3.8 GHz band (planned completion: end of 2017) and their intention to tender it according to market and operators' needs for 5G. The regulator is also planning to re-farm the 3.4-3.6 GHz range. In Italy, the government has stated its intention to proceed with an auction of 3.6-3.8 GHz in 2018. In Ireland, ComReg has completed the award of spectrum rights of use for the 3.4-3.8 GHz frequency band.

Belgium, Austria, Finland, Switzerland have signalled their intention to auction the band for 5G in 2018/2019 timeframe, In Sweden, the regulator has announced its plans to make available the band for 5G trials as early as in 2017. A major large scale country wide 5G trial, government driven will start in 2017. Hungary, Romania and the Czech Republic have all auctioned C-band spectrum already.

In a more long-term perspective, following the release and deployment of 5G in the 3.4-3.8GHz, extending mobile spectrum up to 4.2 GHz could be necessary to meet the growing demand for spectrum for mobile communications. In this context, it may be noted that Ofcom of the UK has recently had a public consultation[11] regarding 3.8-4.2 GHz, "as a candidate band for enhanced spectrum sharing."

DIGITALEUROPE believe that the 3.4-3.8 GHz will be the primary band in the spectrum between 1 GHz and 6 GHz for the introduction of 5G in Europe before 2020 and welcome regulators efforts to reduce fragmentation and to auction it in 2017/2018 timeframe giving operators the possibility to purchase and deploy 5G on 100 MHz blocks of contiguous spectrum.

Spectrum below 6 GHz provides a good combination of coverage and capacity, although without satisfying all of the diverse 5G requirements, e.g. for extremely high bitrates.

26 GHz regulation and implementation

The European Commission mandate to CEPT on harmonized technical conditions for 5G also includes developing channelling arrangements and least restrictive technical conditions for 24.25-27.5 GHz ('26 GHz') frequency band. Furthermore, in the CEPT, ECC PT1 has been tasked to develop an ECC Decision on harmonized technical conditions for MFCN in 24.25-27.5 GHz taking into account 5G requirements by June 2018.

Member States are also progressing with their implementation of the 26 GHz spectrum:

- In the UK, the Government (DCMS and HM treasury) has published its 5G strategy in March 2017 where they have identified scope for 5G to be deployed in the 24.25-27.5 GHz band. Also, OFCOM have initiated a work program on 26 GHz (24.25-27.5 GHz) band availability for early 5G deployment - OFCOM is expected to release the 26.5-27.5 GHz part of the 26 GHz band in a first phase – the band is currently managed by MoD that is leading the work with Ofcom. The remaining part of the 26 GHz band will be released as soon as practicable.

[11] http://stakeholders.ofcom.org.uk/consultations/opportunities-for-spectrum-sharing-innovation/

- In Germany, BNetzA has consulted on the release of spectrum in the 26 GHz band and 28 GHz bands in the context of 5G and is currently working on an award proposal – award is expected in 2018 timeframe.
- In France, ARCEP spectrum consultation included 26 GHz, where the upper part of the band, 26.5-27.5 GHz, is expected to be released first.
- Sweden, PTS is looking at "large-scale 5G tests" in 26 GHz and decided to make available up to 1 GHz (26.5-27.5 GHz) for it in 2017 for trials – release is expected in 2019.
- Finland is looking at "large-scale 5G tests" in 26 GHz, decided to make available up to 1 GHz (26.5-27.5 GHz) for it in 2017 for trials – expected release is in 2019.
- In Spain, the Ministry for Energy, Tourism and Digital Agenda has consulted on the 26GHz band and highlighted the possibility to make available in a first phase 1.4 GHz of spectrum of which 400 MHz in the lower part and 1 GHz in the upper part (of which 500 MHz with some geographical limitations)
- Italian Government is considering awarding the 26.5-27.5 GHz in 2018 timeframe following completion of the ECC harmonization Decision.

Spectrum above 30 GHz

In the first RSPG Opinion on 5G spectrum, 31.8-33.4 GHz is described as “a promising band” for future deployment of 5G services, and 40.5-43.5 GHz is considered as “a viable option for 5G in the longer term”. In the work of ECC PT1, the responsible European group for WRC-19 Agenda Item 1.13 preparation, there are activities for frequency bands beyond 26 GHz. According to the preliminary CEPT position in the draft CEPT Brief on agenda item 1.13, CEPT supports sharing and compatibility studies with a focus on the frequency bands 24.25-27.5 GHz, 31.8-33.4 GHz and 40.5-43.5 GHz.

For further investigations of the 31.8-33.4 GHz band, it is important to keep in mind that the presence of 800 MHz of passive services immediately below 31.8 GHz and their associated protection requirements (ITU-R RR Footnote 5.340: “all emissions are prohibited in the following bands: 31.3-31.5 GHz (R1,2,3), 31.5-31.8 GHz (R2)”) might lead to some additional technical constraints and uncertainty about the final amount of spectrum available for IMT.

Most recently, ECC PT1 set up a new correspondence group dealing with the 40.5-43.5 GHz band to consider studies on sharing and compatibility with services in this frequency band and adjacent bands.

In addition, CEPT considers the band 66-71 GHz under this agenda item.

6. Test Beds and Trials

This section contains information on test beds and trials as available October 2017, noting that new activities are started with high intensity all over the world.[12]

As mentioned in the introduction, a number of test beds have been devised in order to demonstrate the capabilities of future wireless systems. GSA has recently summarised the on-going trials13 (identifying 81 operators in 42 countries carrying out, or about to carry out, tests or trials with 5G enabling and candidate technologies. These tests and trials include features such as MIMO/complex beamforming and network slicing, and have repeatedly demonstrated bitrates in the order of tens of Gbit/s and latency of 1 ms or less.

Figures 6 and 7 below from the GSA report provides additional information on the locations of these tests and trials, and the frequency bands used.

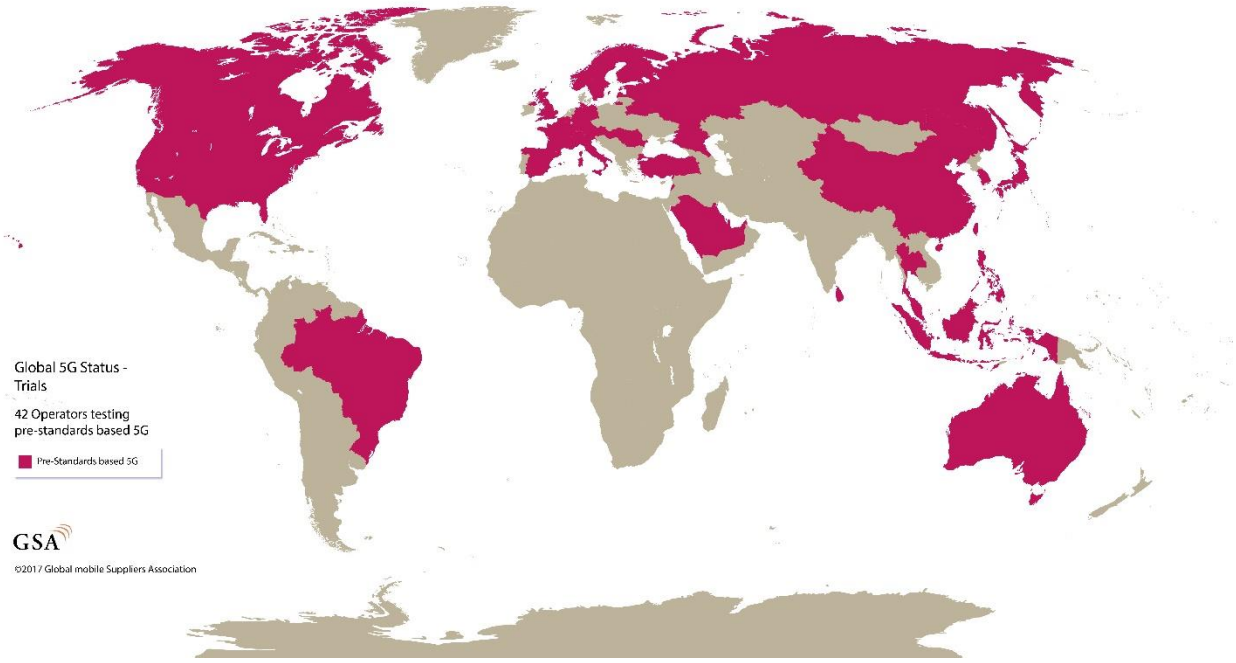

Figure 6: World map with 5G tests and trial locations (source: GSA - https://gsacom.com/paper/5g-trials-global-map/)

[12] Please see the DIGITALEUROPE website for more news and updates in this area (http://www.digitaleurope.org/)
[13] 5G Update – Global Market Trials (https://gsacom.com/paper/5g-update-global-market-trials/)

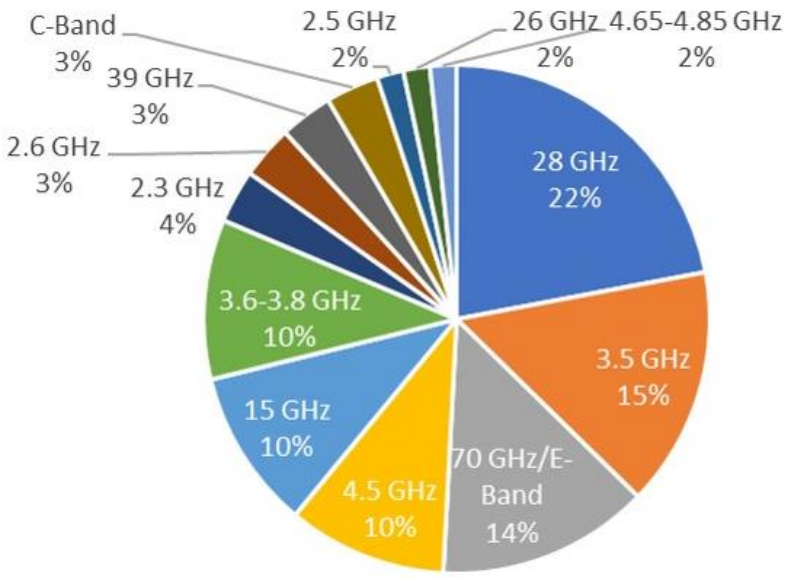

Figure 7: Pie chart outlining global spectrum harmonisation on 5G bands (source: GSA)

Details of the test beds/trials and associated results for just a few are described below:

- **Nokia, Ericsson and Huawei** are cooperating in Finnish 5G trialling[14] activities as partners in 5G Test Network Finland (5GTNF), which is a joint offering of several Finnish 5G testbeds. Nokia is further engaged in several 5G technology trialling with mobile operators in Asia, Europe and the Americas.[15]
- **Huawei** has conducted various 5G NR trials with several operators around the world (including China Mobile, Deutsche Telekom and Telenor), focusing on C-band and mmWave bands (see here). The ongoing 5G NR test projects in C-band are aimed at verifying the key radio aspects of the new technology, e.g. Layer 1 basic capabilities such as SCMA, Massive MIMO, Polar Code, etc. as well as other important features such as Dual Connectivity and Network Slicing. Huawei is also performing tests in the mmWave bands, one recent example being the trial with Telenor where max demo speed of 70 Gbps in the downlink was achieved in E-band spectrum with multi-user MIMO.

  At Mobile World Congress 2017, Ericsson showed a test bed based on 800 MHz bandwidth, 512 BS antennas, 8 UE antennas and massive MIMO beamforming, thus reaching 14+ Gbps for single user MIMO and 25+ Gbps for multiple user MIMO. In a similar set-up, Ericsson and DoCoMo reached 20+ Gbps outdoor (multiple user MIMO) and 10 Gbps at 200m distance outdoor, using massive MIMO beamforming.
- **Samsung** has been demonstrating developments through a series of technology test beds designed to build understanding of the technical performance and characteristics of 5G mmWave technology in collaboration with several mobile operators in Asia, US and Europe. Most recently, mobile handover has been demonstrated with giga-bit data throughput in a multi-cell mmWave network.[16]

[14] 5G Test Network Finland: http://5gtnf.fi/
[15] For more details: http://networks.nokia.com/innovation/5g/press-releases
[16] More information can be found at: https://news.samsung.com/global/ (search on "5G")

- **Qualcomm** announced in February 2017 a number of 5G trials[17] around the world. Furthermore, Qualcomm announced in September 2017 its 5G NR mmWave prototype system[18] based on the 5G New Radio (NR) Release-15 specifications being developed by 3GPP. The prototype system, which operates in millimetre wave (mmWave) spectrum bands above 24 GHz, demonstrates how advanced 5G NR mmWave technologies can be utilized to deliver robust mobile broadband communications at multi-gigabit-per-second data rates in real-world mobile environments. The prototype system also showcases the Company's optimized mmWave RF Front-end design in a smartphone form-factor to test and trial real-world mmWave challenges, such as device and hand-blocking.
- **Intel Corporation** September 2017 announced the "Intel 5G Mobile Trial Platform as first to meet upcoming NR standard" (see here). In December, the 5G non-standalone new radio (NR) standard will be finalized with a goal to accelerate commercial 5G trials and deployments while the final standalone 5G NR standard is being developed. This is a major step forward for 5G, and the energizing and catalytic effect it will have on an array of technology and services. To accelerate development times in 5G, the Intel® 5G Mobile Trial Platform is powered by high-performance Intel® FPGAs and Intel® Core™ processors. Now TEMs can test interoperability with devices sooner, operators can take the platform into real-world situations earlier, and standards bodies can collect data for final specs faster.

  Since Intel announced the Intel® 5G Mobile Trial Platform at MWC in 2016, Intel has been collaborating with industry TEM leaders like Ericsson and Nokia and participating in trials with operators like AT&T, Korea Telecom, NTT DoCoMo and Verizon. Intel will continue to test and drive results and innovations into the full standalone 5G NR standard, which is expected at the end of 2018.
- The **Italian government** has set up a major 5G trial program and offered spectrum covering five cities to enable telecoms operators and other bodies to conduct trials of 5G mobile technology. 100 MHz of spectrum (3.7GHz-3.8GHz) will be made available in Milan, plus Prato and L'Aquila, and Bari and Matera in 2017. Operators and bodies such as universities and research groups will be able to conduct trials in a range of urban settings, including Milan's underground rail network and earthquake reconstruction zones in L'Aquila.
- **Nokia is pursuing a number of 5G** trials worldwide. For example Nokia together with **KDDI** have been trialling 5G on the commercial AirScale radio platform for wireless ultra-broadband in megacities (Tokyo, May 12, 2017, see here) and have further conducted a trial testing future 5G network demands, providing high-speed, one gigabit-per-second connectivity inside an apartment block using the 28GHz band.
- **Ericsson, SK Telecom and BMW Group Korea** have tested 5G at very high speeds (see here) on a racetrack in Yeonjong-do, South Korea. A high-performance network connection supported data transmission from point-to-point from a car driving up to 170km per hour.
- **SoftBank** has acquired an experimental license for 5G in the 28GHz band and started trials (Tokyo, March 15, 2017, see here). The experimental license was granted to conduct tests on the 28GHz frequency band, a candidate for 5G mobile communications in Japan. SoftBank will conduct indoor and outdoor trials in

[17] https://www.qualcomm.com/news/releases/2017/02/26/ericsson-qualcomm-and-vodafone-trial-5g-new-radio-unified-5g ; https://www.qualcomm.com/news/releases/2017/09/11/qualcomm-and-nokia-collaborate-driving-wide-scale-mobile-5g-nr-deployments; https://www.qualcomm.com/news/releases/2017/02/26/qualcomm-ericsson-and-ntt-docomo-announce-collaboration-5g-nr-trials ; https://www.qualcomm.com/news/releases/2017/02/26/telstra-ericsson-and-qualcomm-collaborate-accelerate-5g-nr-deployment

[18] https://www.qualcomm.com/news/releases/2017/09/11/qualcomm-announces-5g-nr-mmwave-prototype-accelerate-mobile-deployments

Tokyo Waterfront City (Daiba District) using the 28GHz band with a view to future commercial deployment.

- National Instruments demonstrated a 28 GHz real-time, over-the-air prototype aligned with the Verizon 5G specification at the IEEE WCN Conference (San Francisco, March 2017). The system uses OFDM with eight component carriers in a 2x2 downlink MU-MIMO configuration with hybrid beamforming and a self-contained subframe, yielding a 5 Gbit/s peak throughput, and is scalable to over 20 Gbit/s with eight MIMO streams (see here).

7. Product Availability

Harmonisation Aspects

A key aspect of the frequency allocation and licensing for 5G is to achieve global and regional harmonisation, so as to enable economy-of-scale advantages. This is particularly important during the initial launch phase of a new technology such as 5G. Enabling global and regional scale provides confidence to operators, vendors and businesses to invest at an early stage in the development of 5G and the creation of the new ecosystem. This helps develop a competitive market with a wide range of products and services with the benefit to all, including consumers and a nation's productivity and competitiveness.

Another important reason is that with the advanced antenna systems of 5G, both for base stations and terminals, implementation of too many separate bands above 10 GHz will add significant or even insurmountable complexity to the design of equipment. The key challenge for higher frequency ranges is associated with the implementation of the beam steering antenna arrays whose performance depends largely on the size and spacing of physical elements that are specific to the frequencies being deployed. This challenge is very important when considering the limited "real estate" for antenna array placement inside a small form factor device.

However, an important observation is that sufficient harmonization does not rely on having exactly the same spectrum available in different regions, which may be difficult to achieve due to different situations with incumbents and local requirements.

In order to maximise the addressable market for any device, particularly during the initial launch phase of 5G, administrations should take into account regional spectrum and licensing developments, and leverage these wherever possible, to help enable global economies of scale.

- Low Band; The European selection of 700 MHz as the pioneer band in the low band frequency range is well in line with the global harmonization efforts, as 700 MHz band 28 (APT700 FDD) is the fastest growing sub 1GHz band for LTE network deployments. This is a natural consequence of the excellent coverage characteristics of this band, also proving possibilities for many IoT applications. More than 50 countries/territories have allocated or committed to Band 38 for LTE system deployments, not counting European countries that will use a frequency arrangement compatible with the lower duplexer of this band.

- Mid band; As discussed in Section 4, the 3400-3800 MHz band is the prime spectrum suitable for the introduction of 5G-based services in Europe [reference to RSPG Opinion and/or RSC Mandate to CEPT]. Given that this spectrum is already harmonised in the CEPT countries for mobile networks (IMT-Advanced) [reference to ECC Decision (11)06 and Commission Decision 2014/276/EU] and offers wide channel bandwidth, it can be used for commercial 5G deployments before 2020 and help in establishing a global C-band equipment eco-system operating over the whole range of 3300-4200 MHz.
  There is considerable global momentum for this band, considering the development in Asia and the U.S., see Section 3, and also the potential for other regions. DIGITALEUROPE expects the majority of initial 5G networks across Europe to be launched in 3400-3800 MHz band and boost the 5G developments in C-band world-wide.

- High Band; Canada, Korea, Japan and the US are releasing spectrum within the 28 GHz band and China has consulted on releasing spectrum in the 26GHz and 42 GHz bands. Two band plans will be defined in 3GPP for 5G in the 24.25-29.5 GHz frequency range: 24.25-27.50 and 26.50-29.50 GHz with the target for completion by December 2017 and the latest by June 2018 during Release 15. These two band plans

share 26.50-27.50 GHz in common and there is therefore an opportunity to globally harmonise 1 GHz of spectrum within this range.

This global spectrum enables Europe to benefit from early deployments and early commercially available equipment from these other countries which are planning launches within the 2018-2020 timeframe. This all helps to generate global economies of scale which are essential in the initial phase of establishing a competitive infrastructure and terminals market for 5G equipment.

As the networks scale the previously established equipment market can then continue to grow, expand into new spectrum that could potentially be made available in a second phase and other markets can be addressed which would benefit from this global scale. This is why it's important that licensing of the 26 GHz spectrum in Europe includes at least the global 1GHz (26.50 – 27.50 GHz) in a first initial phase to take advantage of 5G equipment that has been developed for other countries in other regions.

Similarly, 37-40 GHz is in the list of the "Spectrum Frontiers" rulemaking, see Table 2, and 37.5-40 GHz received significant global support in preparation for WRC-15. Noting that the frequency range 40-43.5 GHz is not heavily used in some regions, which appears to be the case also in Europe, administrations may thus want to consider further investigation of the feasibility and benefits from the 37-43.5 GHz and the regional and global harmonisation potential for this spectrum range.

Figure 8: Two examples of proximity of 5G frequency bands and potential overlap, providing opportunities for synergy effects and global roaming.

Equipment Availability

A broad range of 5G products will be available in 3300-4200 MHz and 24.25-29.50 GHz frequency ranges, in line with market demand: macro and small cell base stations, end user equipment ranging from wireless routers to smartphones, as well as wireless modules to be integrated into a broader range of devices.

Chipset suppliers are fully committed to supporting the 3300-4200 MHz range and 24.25-29.50GHz range. In the mid band it is clear that devices will support the 3300-3800 MHz as well as the 3600-4200 MHz range from the outset. In broad terms, regulators will be able to start making available any portion within the 3300-4200 MHz range, with the possibility of expanding the spectrum availability over time, without impacts on the existing devices. 5G trials and interoperability testing (both eLTE and 5G-NR) in the 3300-4200 MHz range will start late in 2017. Commercial readiness of 5G-NR is expected in 2018 targeting broader commercialisation from 2019. In the high band 26.50-29.50 GHz is the initial focus in the first phase and will be expanded to cover the whole of the 24.25-29.50GHz in line with anticipated expanded 26GHz spectrum availability in Europe and China.

A number of announcements have been made regarding commercial equipment availability:

- Intel 5G Modem supports 5G operation in both sub-6GHz bands and 28 GHz mmWave spectrum in the U.S., Korea, and Japan with a single device implementation. It pairs the 5G RFIC with the 28 GHz RFIC—supporting 5G New Radio features including low latency frame structure, advanced channel coding, massive MIMO, and beamforming. In combining the capabilities of the 28 GHz RFIC, which is already commercially available, and the 5G RFIC, the Intel® 5G Modem delivers on critical 5G requirements for multi-Gbps throughput, hundreds of MHz aggregated bandwidth and ultra-low latency.
- Qualcomm has announced the availability of its X50 Snapdragon modem which offers 28GHz support, 4G/5G multi-mode with dual connectivity and up to 5Gbps download speeds. The first commercial products featuring Snapdragon X50 5G NR modems are expected to be available in 2019.
- Samsung has unveiled its end-to-end portfolio of 5G mobile network products and solutions for 2017 which included chipsets, consumer devices for fixed wireless access connectivity, a 5G Radio Base Station (5G Access Unit) and Next-Generation Core Network infrastructure.
- Ericsson has announced availability in 2017 of a 5G NR-capable radio for mid-band spectrum, Ericsson AIR 6468, featuring 64 transmit and 64 receive antennas enabling support of Massive MIMO and Multi-User MIMO. AIR 6468 is designed for compatibility with the 5G NR standard while also supporting LTE. Ericsson is further planning to release 5G base stations for 24.5 – 27.5 GHz and 26.5 – 29.5 GHz by the first half of 2019.
- Huawei will be ready to provide E2E 5G commercial products compliant with the 3GPP standard in 2018, including New Radio and New Core equipment.
- Nokia will implement early 5G specifications, enhancing 5G FIRST with the 3GPP 5G Phase I protocol covering low, mid and high bands. Equipment for 28GHz is already available for trials since early 2017 as part of the 5G FIRST solution and commercial availability is planned for 2019. This RF can also be used for early trials at 26 GHz in the upper 1 GHz of the band.
- Terminals and devices usually lag the announcements from the chipset and infrastructure community and announcements on these are anticipated over the next 12-24 months.

8. Licensing of 5G Spectrum

DIGITALEUROPE notes that licencing conditions employed by European countries may greatly influence the success of 5G in Europe. It is noted that whereas European countries have been extremely successful in the technical harmonisation of spectrum, there is still little to no harmonisation of the licencing conditions applicable to each band. With different licencing conditions applicable in different countries of Europe, there is little hope to achieve the promises of the single market, especially for vertical applications which do not necessarily benefit from economies of scale.

While pan European licencing mechanisms have been regularly rejected by Member States, DIGITALEUROPE notes that most European countries manage to adopt CEPT/ECC decisions without ending up unduly restricted in their national flexibility. For 5G deployment, DIGITALEUROPE thus recommends adopting mechanisms to ensure as comprehensive as possible a harmonisation of the licencing conditions (license duration, price, spectrum packaging and availability, regulatory conditions) applicable in each European country to any spectrum band.

License duration and license cost have a significant and potentially negative impact on the investments in 5G networks and technologies. DIGITALEUROPE recommends adopting spectrum award mechanisms maximising investments in networks and technologies. Longer license options enable safer investment by MNOs, irrespective of the regulatory control mechanisms. Ideally, unlimited licenses with adequate regulatory mechanisms are the most investment friendly option. Similarly, spectrum costs are typically deducted from the overall budget of the operators, reducing their investment power, when it is clear that investments are lacking and would be beneficial to the economy. Award mechanisms should favour investment, not suppress it.

5G networks will be more flexible and more adaptable than previous mobile networks to be able to respond to the requirements of many services beyond mobile broadband. 5G will propose mechanisms to enable both verticals and mobile broadband to access the spectrum. In general, the idea of 5G is to slice the network, not to slice the spectrum.

In particular, MNOs require access to licensed spectrum in order to invest massively and deliver both coverage and economies of scale. DIGITALEUROPE recommends awarding the 700 MHz and 3400-3800 MHz and 26 GHz bands on the basis of individual national licensing.

- While advanced technical spectrum sharing mechanisms have been proposed around the world (e.g. CBRS, they mainly apply to horizontal sharing[19] mechanisms between similar players. DIGITALEUROPE does not currently regard sharing mechanisms such as CBRS as relevant in the context of 5G in Europe. The key consideration should be how to ensure adequate access to spectrum to both MNOs (mobile broadband) and vertical services. To ensure that verticals get access to spectrum, DIGITALEUROPE sees MNO managing the service for verticals (network slicing) as an excellent solution. In addition, DIGITALEUROPE recommends exploring and harmonising options such as: sub-leasing the spectrum (possibly with 'use it or lease it' regulatory obligations (ex-post) once voluntary sub-leasing has been seen as not efficiently addressing the situation),
- or any appropriate regulatory options ensuring that both MNOs and verticals get access to spectrum in order for all to benefit from investments and economies of scale.

[19] Horizontal sharing occurs between users that have no inherent priority over each other. Wireless LANs in Europe implements such type of horizontal sharing: several users can deploy independently several wireless LAN networks, which may be based on different technologies, as long as each equipment respect the spectrum access rules defined on the appropriate harmonised standard. LBT is one such technology solution to enable horizontal sharing.

In particular, for the 5G pioneer bands, DIGITALEUROPE proposes the following specific recommendations for the 5G pioneer bands:

Band	Licensing recommendation
700 MHz	National individual licenses, >=2x10MHz*
3400-3800 MHz	National individual licenses, >=80-100MHz Regulatory obligation may be introduced to ensure productive verticals-MNO cooperation
26 GHz	National individual Licenses, >=400-1000MHz. Several options to enable both MNOs and verticals including network slicing, 'use it or lease it'.

Table 3: Licensing Recommendations

9. Recommendations on 5G spectrum for Europe

Based on the above, DIGITALEUROPE proposes that for developing commercial services:

1. Europe seizes this once in a generation opportunity to achieve full nationwide ultrafast 5G mobile broadband by 2025. DIGITALEUROPE thus supports the approach of licensing the EU pioneer bands 700 MHz, 3.5 GHz and 26 GHz by the end of 2019 to meet initial commercial deployments in 2020.
2. Europe will benefit from recognising and taking advantage of the early developments in other regions in order to be in a leading position for the development of 5G services. In particular, the momentum in the frequency ranges 3.4-3.8 GHz and 26.5-29.5 GHz are noted.
3. Activities both within and outside of ITU-R towards obtaining 5G spectrum should be given due consideration to ensure timely availability of sufficient amounts of spectrum as well as global/regional harmonization.
4. Spectrum in different frequency ranges should be provided to satisfy requirements for different 5G use cases, with needs for different bandwidths and propagation characteristics.
5. Frequency bands below 1 GHz will be very suitable for applications with high demands on coverage but lower demands on bandwidth (e.g. IoT applications).
6. Spectrum in the 3.4-3.8 GHz and 3.8-4.2 GHz ranges should be considered as essential for 5G deployment with both good bandwidths and good coverage. In particular, the already harmonized mobile band 3.4-3.8 GHz provides a unique opportunity for early and wide-scale 5G deployment and should be considered as the core 5G spectrum below 6 GHz for Europe. It is of paramount importance to clear and defragment this band to enable contiguous bandwidths in the order of 100 MHz for MNOs. An extension up to 4.2 GHz should be considered for the future. It is further noted however that additional bands, both below and above 6 GHz, will also be necessary to achieve full 5G capabilities.
7. 24.25-27.5 GHz is necessary for achieving very high data rates and capacity. There is the possibility to leverage equipment development in other regions such as the US, Korea and Japan (26.50-29.50 GHz), in the sense that there will be synergy effects between equipment for these two frequency bands. Compatibility with existing services in, and adjacent to, the band will need to be investigated further and with a matter of urgency to avoid delays in the process of harmonizing and authorizing the band for 5G and to enable services to be launched in Europe by 2020. DIGITALEUROPE believes that 26 GHz band should be licensed early enough to enable deployments by 2020. Where the whole '26 GHz' band could not be made available in one step, the frequency range 26.5-27.5 GHz should be licensed in a first phase in 2018. In case of a two-phased approach, countries are invited to commence planning for re-farming measures in 2017 so that this spectrum 24.25-26.5 GHz, is made available for 5G in a second phase, following the early launch in the range 26.5 GHz to 27.5 GHz.
8. For more long-term deployment, consideration should be given to the 37-43.5 GHz range. The bands 37-38.6 GHz and 38.6-40 GHz are included in the R&O concerning 5G from FCC, and there is thus already now a certain momentum for this frequency range. For Europe, due to the point-to-point fixed links in 37.5-39.5 MHz and uncoordinated FSS Earth stations in 39.5-40.5 GHz, it is the 40.5-43.5 GHz band that is suitable.
9. Spectrum above 60 GHz should be considered in the ITU-R process, and may provide extreme bandwidths for indoor and short-range 5G applications.

10. Licensing mechanisms should be chosen carefully, to achieve harmonisation of licensing conditions (duration, price, spectrum packaging and availability, regulatory conditions) between different countries. Spectrum award mechanisms should be designed to maximise investments in networks and technologies, in particular this implies longer license options for safe investments and reasonable spectrum costs.
11. For the EU pioneer bands in particular (700 MHz, 3.4-3.8 GHz and 26 GHz), DIGITALEUROPE recommends that they should be awarded on the basis of individual national licensing.
12. Due consideration should be given to IoT solutions and verticals. MNO may manage vertical services by network slicing, or may sub-lease spectrum. Other regulatory options may be considered for providing both MNOs and verticals with sufficient spectrum.

DIGITALEUROPE further notes that standardization in ITU-R for IMT-2020 is progressing according to plans, that 3GPP has accelerated its schedule for the 5G NR specification and that there will be timely availability of equipment for European pioneer bands, as evidenced by statements from vendors as well as a very large number of on-going tests and field trials on a global basis.

10. List of Acronyms and Abbreviations

3GPP – 3G Partnership Project

5G NORMA - 5G NOvel Radio Multiservice adaptive network Architecture

5GPPP – 5G Public Private Partnership

5GMF – 5G Mobile Forum

AI – Air Interface

ECP – European Common Proposal

FANTASTIC-5G - Flexible Air iNTerfAce for Scalable service delivery wiThin wIreless Communication networks of the 5th Generation

IMT - International Mobile Telecommunications

ITU-R – International Telecommunications Union Radiocommunication Sector

M2M – Machine-to-Machine

MBB – Mobile Broadband

METIS - Mobile and wireless communications Enablers for the Twenty-twenty Information Society

MIMO - Multiple Input Multiple Output

mmMAGIC - Millimetre-Wave Based Mobile Radio Access Network for Fifth Generation Integrated Communications

NGMN – Next Generation Mobile Networks

OFDM - Orthogonal Frequency-Division Multiplexing

QoS - Quality-of-Service

RSPP - Radio Spectrum Policy Programme

UHD – Ultra High Definition

WRC-15 – World Radiocommunications Conference 2015

WRC-19 – World Radiocommunications Conference 2019

--
For more information, please contact:
Jochen Mistiaen, DIGITALEUROPE Policy Manager
+32 496 20 54 11 or jochen.mistiaen@DIGITALEUROPE.org

ABOUT DIGITALEUROPE

DIGITALEUROPE represents the digital technology industry in Europe. Our members include some of the world's largest IT, telecoms and consumer electronics companies and national associations from every part of Europe. DIGITALEUROPE wants European businesses and citizens to benefit fully from digital technologies and for Europe to grow, attract and sustain the world's best digital technology companies. DIGITALEUROPE ensures industry participation in the development and implementation of EU policies.

DIGITALEUROPE's members include in total 25,000 ICT Companies in Europe represented by 61 corporate members and 37 national trade associations from across Europe. Our website provides further information on our recent news and activities: http://www.digitaleurope.org

DIGITALEUROPE MEMBERSHIP

Corporate Members

Adobe, Airbus, Amazon, AMD, Apple, BlackBerry, Bose, Brother, CA Technologies, Canon, Cisco, Dell, Dropbox, Epson, Ericsson, Fujitsu, Google, Hewlett Packard Enterprise, Hitachi, HP Inc., Huawei, IBM, Intel, JVC Kenwood Group, Konica Minolta, Kyocera, Lenovo, Lexmark, LG Electronics, Loewe, Microsoft, Mitsubishi Electric Europe, Motorola Solutions, MSD Europe Inc., NEC, Nokia, Nvidia Ltd., Océ, Oki, Oracle, Panasonic Europe, Philips, Pioneer, Qualcomm, Ricoh Europe PLC, Samsung, SAP, SAS, Schneider Electric, Sharp Electronics, Siemens, Sony, Swatch Group, Tata Consultancy Services, Technicolor, Texas Instruments, Toshiba, TP Vision, VMware, Western Digital, Xerox, Zebra Technologies.

National Trade Associations

Austria: IOÖ
Belarus: INFOPARK
Belgium: AGORIA
Bulgaria: BAIT
Cyprus: CITEA
Denmark: DI Digital, IT-BRANCHEN
Estonia: ITL
Finland: TIF
France: AFNUM, Force Numérique, Tech in France
Germany: BITKOM, ZVEI
Greece: SEPE
Hungary: IVSZ
Ireland: TECHNOLOGY IRELAND
Italy: ANITEC
Lithuania: INFOBALT
Netherlands: Nederland ICT, FIAR
Poland: KIGEIT, PIIT, ZIPSEE
Portugal: AGEFE
Romania: ANIS, APDETIC
Slovakia: ITAS
Slovenia: GZS
Spain: AMETIC
Sweden: Foreningen Teknikföretagen i Sverige, IT&Telekomföretagen
Switzerland: SWICO
Turkey: Digital Turkey Platform, ECID
Ukraine: IT UKRAINE
United Kingdom: techUK