

# **Spectrum for Terrestrial 5G Networks: Licensing Developments Worldwide**

Report based on information gathered as part of the GSA's  
ongoing 5G research programme

July 2019

## Introduction

*At present, GSA is aware of 71 countries (or territories, special administrative regions, disputed territories and dependencies) actively considering suitable spectrum for 5G (whether dedicated to 5G or made available through a technology-neutral licence).*

*This figure excludes such initiatives in relation to spectrum that is being allocated primarily for the provision of 3G or 4G services.*

*Some countries have multiple initiatives underway.*

This report provides a snapshot of the global status of national 5G spectrum plans as of 25 July 2019. As national regulators plot their countries' moves towards 5G, there are important choices to be made about which portions of the spectral range should be either dedicated to terrestrial 5G networks and services or at least accessible to 5G networks and services.

This report reflects a market that is in constant flux and feedback is greatly appreciated to keep it current. The next update will be published in August 2019. Please send comments and information to [research@gsacom.com](mailto:research@gsacom.com).

Important changes since the last report include:

- Austria: consultation launched on plans for spectrum at 2300 MHz and 26 GHz.
- Bahrain: spectrum allocated at 800 MHz and 2600 MHz (TDD).
- Canada: ISED announced plans in relation to C-Band and mmWave spectrum.
- Czechia: consultation launched on the conditions for the tender to use spectrum at 700 MHz and 3400–3600 MHz.
- Ecuador: spectrum auction plans updated.
- France: ARCEP set the end date for L-Band licences with a view to opening for 5G and launched consultation on spectrum plans for 3400–3800 MHz.
- Germany: use of previously auctioned spectrum at 700 MHz approved.
- Hong Kong: new Localised Wireless Broadband Licences in the 26 GHz and 28 GHz bands created and applications opened for participation in 5G auctions.
- Hungary: timetable and spectrum plan for September auction finalised.
- Ireland: multi-band spectrum consultation launched.
- Israel: tender of spectrum at 700 MHz, 2600 MHz and 3500–3800 MHz launched.
- Malaysia: plans announced for tenders of spectrum at 700 MHz and 2300 MHz.
- Myanmar: consultation on multi-band 4G/5G auction in 2020.
- Norway: consultation launched on spectrum bands for 5G, including revised timetable.

- Peru: consultation launched on plans to open up 3400–3800 MHz for advanced broadband services.
- Slovakia: H2 2019 timetable announced for 700 MHz tender.
- Spain: 700 MHz spectrum release approved by Royal Decree.
- Thailand: sale of spectrum at 700 MHz completed.
- United Kingdom: Ofcom announced spectrum sharing in several key bands.
- USA: FCC announced decision to enable flexible use of spectrum at 2.5 GHz.

## Frequency range designations and bands

In this report, we consider spectrum in specific bands for which auctions or long-term designations are being considered. These include new 5G/NR bands defined by 3GPP in Release 15, which are being defined in the following two frequency ranges (FR) in Table 1.

Table 1: Frequency ranges

Frequency range designation	Corresponding frequency range
FR1	410–7125 MHz
FR2	24250–52600 MHz

FR1 bands at the time of development of this report are defined in Table 2.

Table 2: FR1 bands

NR operating band	Uplink (UL) operating band	Downlink (DL) operating band	Duplex mode
n1	1920–1980 MHz	2110–2170 MHz	FDD
n2	1850–1910 MHz	1930–1990 MHz	FDD
n3	1710–1785 MHz	1805–1880 MHz	FDD
n5	824–849 MHz	869–894 MHz	FDD
n7	2500–2570 MHz	2620–2690 MHz	FDD
n8	880–915 MHz	925–960 MHz	FDD
n12	699–716 MHz	729–746 MHz	FDD
n20	832–862 MHz	791–821 MHz	FDD
n25	1850–1915 MHz	1930–1995 MHz	FDD
n28	703–748 MHz	758–803 MHz	FDD
n34	2010–2025 MHz	2010–2025 MHz	TDD
n38	2570–2620 MHz	2570–2620 MHz	TDD
n39	1880–1920 MHz	1880–1920 MHz	TDD
n40	2300–2400 MHz	2300–2400 MHz	TDD
n41	2496–2690 MHz	2496–2690 MHz	TDD
n50	1432–1517 MHz	1432–1517 MHz	TDD
n51	1427–1432 MHz	1427–1432 MHz	TDD

NR operating band	Uplink (UL) operating band	Downlink (DL) operating band	Duplex mode
n66	1710–1780 MHz	2110–2200 MHz	FDD
n70	1695–1710 MHz	1995–2020 MHz	FDD
n71	663–698 MHz	617–652 MHz	FDD
n74	1427–1470 MHz	1475–1518 MHz	FDD
n75	N/A	1432–1517 MHz	SDL
n76	N/A	1427–1432 MHz	SDL
n77	3300–4200 MHz	3300–4200 MHz	TDD
n78	3300–3800 MHz	3300–3800 MHz	TDD
n79	4400–5000 MHz	4400–5000 MHz	TDD
n80	1710–1785 MHz	N/A	SUL
n81	880–915 MHz	N/A	SUL
n82	832–862 MHz	N/A	SUL
n83	703–748 MHz	N/A	SUL
n84	1920–1980 MHz	N/A	SUL
n86	1710–1780 MHz	N/A	SUL

FR2 bands at the time of development of this report are defined in Table 3.

Table 3: FR2 bands

NR operating band	Uplink (UL) and downlink (DL)	Duplex mode
n257	26500–29500 MHz	TDD
n258	24250–27500 MHz	TDD
n260	37000–40000 MHz	TDD
n261	27500–28350 MHz	TDD

There are also a number of other spectrum bands being considered by national regulators that are not yet covered by 3GPP specifications:

- 5925–7150 MHz, considered in USA and CEPT (5925–6425 MHz) for unlicensed use.
- 64–86 GHz, or parts thereof.

Note that various parts of the 64–86 GHz range are considered differently in different regions. For instance, 64–71 GHz is set aside for unlicensed use in North America and is under consideration in CEPT (66–71 GHz); 66–76 GHz and 81–86 GHz are under study in ITU-R as a possible range for IMT-2020, to be decided at WRC-19.

Within CEPT, there is desire that the 66–71 GHz band, while being supported for an IMT Identification, should also made available for non-IMT technologies on an equal basis for licence-exempt use. In addition, 3GPP should ideally be considering the full 57–71 GHz range and not just the 66–71 GHz part for IMT.

In many cases, regulators are making subsets of the newer bands available, freeing them up in chunks when they can migrate existing users (such as satellite, military, broadcasters or other users) to different blocks of spectrum.

Analysis of spectrum plans is divided into two main groups: plans associated with bands that are explicitly designated for 5G (or LTE and 5G) and separately, plans associated with bands licensed or allocated on a technology-neutral basis, or allocated much more broadly for mobile services or mobile broadband services. We only cover plans for, or auctions of, spectrum being set aside specifically for LTE, 3G or 2G technologies (i.e. specifically not 5G) where inclusion is useful for clarity.

## Global overview

*In Europe, 17 countries have already completed auctions of 5G spectrum and 20 have definite 5G-suitable (dedicated or technology neutral) spectrum auctions/allocations planned between 2019 and 2021.*

*There are planned 5G auctions/allocations confirmed in at least nine countries in Asia Pacific*

At present, GSA is aware of 71 countries in the world that are actively considering suitable spectrum for 5G (whether dedicated to 5G or made available through a technology-neutral licence). This figure excludes countries undertaking such initiatives in relation to spectrum that is being allocated primarily for the provision of 3G or 4G services. Some countries have multiple initiatives underway.

(Note: all references to countries in this document can be read as also including territories, special administrative regions, disputed territories and dependencies.)

In Europe, 17 countries have already completed auctions of 5G suitable (dedicated or technology neutral) spectrum (Albania, Austria, Croatia, Czechia, Denmark, Finland, Germany, Greece, Ireland, Italy, Latvia, Norway, Slovakia, Spain, Sweden, Switzerland and the UK). Twenty countries are known to have definite 5G-suitable (dedicated or technology neutral) spectrum auctions/allocations planned between 2019 and 2021 (Austria, Belgium, Cyprus, Czechia, Estonia, France, Greece, Hungary, Kosovo, Luxembourg, Macedonia, Netherlands, Norway, Poland, Romania, Slovakia, Slovenia, Spain, Sweden and the UK).

There are planned 5G-suitable auctions/allocations confirmed in at least nine countries in Asia Pacific (Australia, Hong Kong, India, Malaysia, Myanmar, New Zealand, Singapore, Taiwan and Thailand) between 2019 and 2021. Some have already been completed. In June 2018, the Republic of Korea completed a 5G auction for spectrum in the 3.42–3.7 GHz and 26.5–28.9 GHz frequency bands; Australia has auctioned 5G spectrum at 3.5 GHz; Japan allocated spectrum in various bands; Hong Kong and Thailand have recently issued spectrum on technology-neutral terms; and China has reserved key bands for 5G (though has not licensed individual operators yet).

In the Americas, the USA typically issues spectrum on a technology-neutral basis, making any such awards potentially useable for 5G. Recently, it has issued spectrum on a technology-neutral basis that can be used for 5G in the 600 MHz range. It has also confirmed rights to use the spectrum that was awarded many years ago at 28 GHz (27.5–28.35 GHz) and 39 GHz (37–40 GHz) for 5G and in October 2018, changed the rules to make CBRS spectrum more attractive to 5G investors. In January 2019, it completed an auction of spectrum at 28 GHz, and in May 2019 completed an auction of spectrum at 24 GHz. Operators in the USA will also use 2.5 GHz band for 5G. Mexico has auctioned spectrum between 2500 MHz and 2690 MHz for 4G and 5G. Canada completed an auction of spectrum at 600 MHz in April 2019. Meanwhile, Argentina, Brazil, Canada, Colombia, Ecuador, El Salvador, Mexico and the USA have announced timetables for future auctions/allocations of spectrum potentially suitable for 5G.

*Worldwide, 34 countries have completed 5G-suitable allocations or licensing procedures in at least one spectrum band (including technology-neutral licences, or licences for mobile broadband services).*

Of the countries in the Middle East and Africa, Saudi Arabia has concluded two auctions of spectrum suitable for 4G and 5G services at 2300 MHz, 2600 MHz and 3500 MHz, plus auctions of spectrum at 700 MHz, 800 MHz and 1800 MHz for next-generation high-speed wireless data services; UAE has allocated spectrum to enable network rollout in advance of WRC-19; Oman and Qatar have awarded spectrum for 5G services; Tanzania has awarded spectrum at 700 MHz for ICT services; and Ghana has auctioned spectrum at 800 MHz for mobile services. Most recently, in May 2019 Kuwait awarded spectrum licences at 3.5 GHz, and in July, Bahrain allocated and auctioned spectrum at 800 MHz and 2600 MHz and Israel launched an auction of multiple spectrum bands. Meanwhile, South Africa is planning an auction in the 800 MHz range for IMT services, Hong Kong has a multi-band auction underway and Singapore is planning auctions of spectrum at 3500 MHz, 26 GHz and 28 GHz.

Worldwide, in total, 34 countries have recently completed 5G-suitable allocations or licensing procedures in at least one spectrum band (including technology-neutral licences, or licences for mobile broadband services).

Thirty-nine countries have announced formal (date-specified) plans for allocating 5G-suitable frequencies between now and end-2021 (including technology-neutral licences, or licences for mobile broadband services).

## Licensing activity detail by country

This section summarises, by region and country, the 5G spectrum activity observed by GSA in the course of its research programme. This includes bands being considered for 5G, soon to be auctioned, considered for auction and those already granted to operators. All dates indicated for auctions are correct to the best of our knowledge at the time of publication, but should be treated as provisional or aspirational until all consultations and legal processes have been completed.

In addition to those countries with licensing plans specifically designated for 5G, the information also includes a number of other countries considering, planning or in the process of auctioning bands that could be used for any technology (licensed on a technology-neutral basis), or used to deliver mobile broadband services and hence are potentially useable for 5G but are not explicitly designated for 5G at this stage.

### The Americas

Figure 1: National spectrum positions in the C-band – The Americas (ITU Region 2)

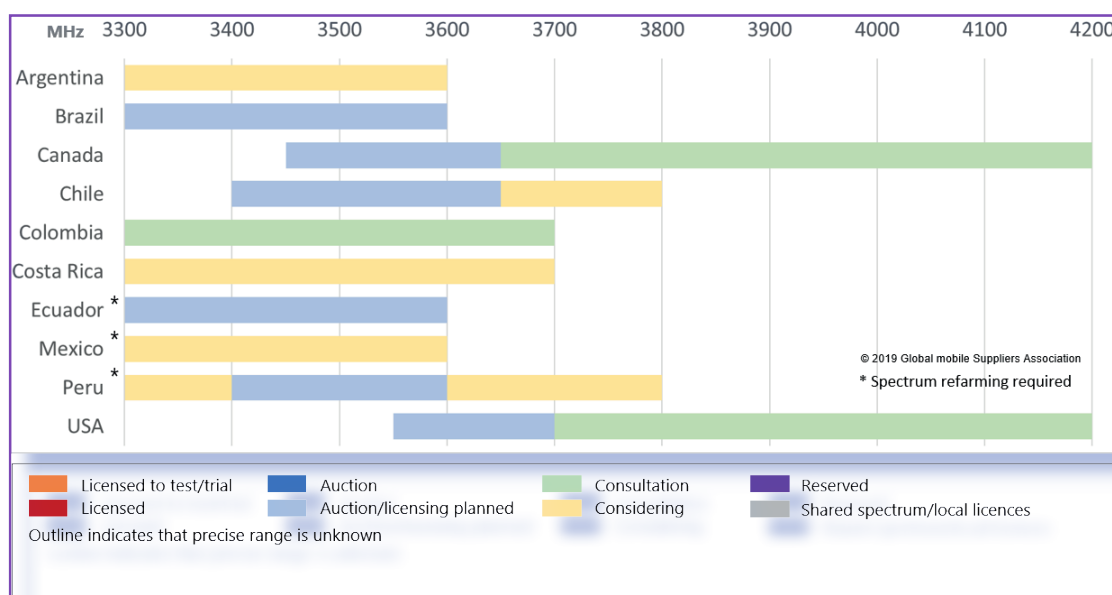
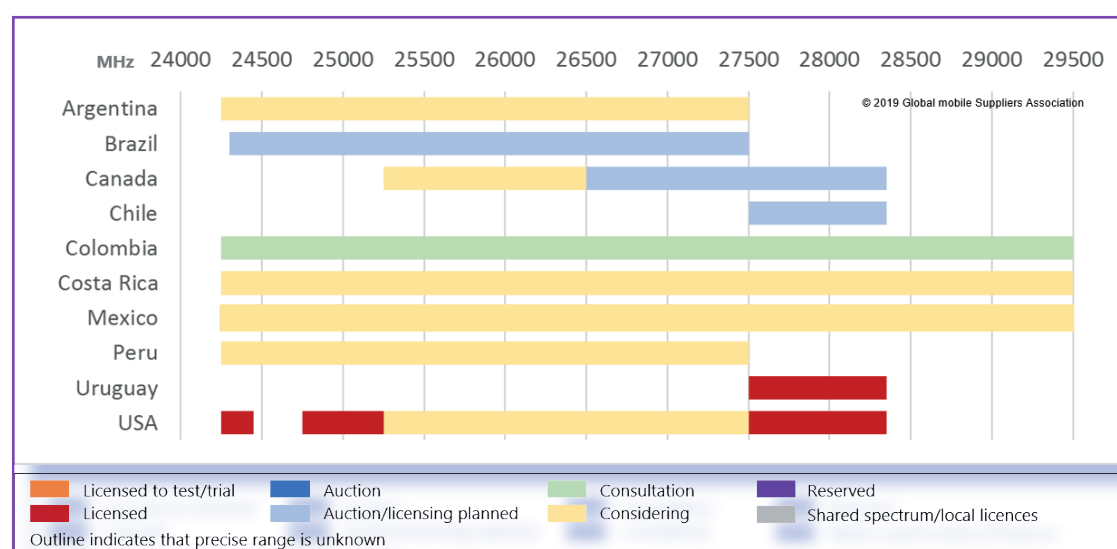




Figure 2: National spectrum positions in the 26 GHz and 28 GHz bands – The Americas (ITU Region 2)



### Argentina (Ministry of Modernization, Ente Nacional de Comunicaciones (ENACOM))

Argentina has been considering release of spectrum at 3300–3600 MHz and the government has begun the refarming process for the 3400–3600 MHz band. It is also considering an auction of the 1427–1517 MHz band.

A governmental decree, published in the Official Bulletin of Argentina in January 2019 (decree 58/2019), says that the government has instructed the regulator ENACOM to make at least 20% of the spectrum, previously exclusively available to satellite provider ARSAT, available for public, private, regional or local ICT services. The decree covers spectrum at 738–748 MHz/793–803 MHz, 1745–1770 MHz/2145–2170 MHz and three regional blocks of FDD spectrum at 1800 MHz in the 1880–1905 MHz and 1960–1985 MHz ranges.

ENACOM has also been creating local licences enabling the use of spectrum at 450–470 MHz. In March 2019, ENACOM continued this process and announced two new licences at 450 MHz to enable improvement of rural connectivity. This was followed in May 2019 by the decision to create 126 local licences allowing the use of spectrum at 450 MHz to provide fixed and mobile services including broadband internet. By that stage it had created licences covering 272 areas in 15 provinces.

### Brazil (Brazilian National Telecommunications Agency (ANATEL))

Following a series of consultations, in May 2019 ANATEL reported that the award of spectrum at 2300–2400 MHz and 3300–3600 MHz had been



approved, and that an auction is expected to begin in the first quarter of 2020. The award of spectrum will be subject to avoiding interference for existing users of these and adjacent bands. The spectrum is expected to be awarded on a technology-neutral basis, but with use for 5G very much in mind.

Separately, ANATEL also approved the study of the 700 MHz and 26 GHz frequency bands for 5G, and the president of ANATEL went on record in local press (*Teletime*) in February 2019 as saying that the 700 MHz band could possibly be auctioned in Q1 2020.

The latest information from Anatel in June 2019 is that there will be an auction in March 2020 covering four bands:

- 700 MHz (709–718/763–773)
- 2300 MHz (2300–2390 MHz TDD)
- 3500 MHz (3300–33600 MHz TDD)
- 26 GHz (24.3 GHz–27.5 GHz TDD)

ANATEL has additionally been running a public consultation into re-designating use of spectrum in the L-Band (1427–1518 MHz) for use for IMT services.

#### **Canada (Innovation, Science and Economic Development (ISED) Canada)**

In June 2018, Canada published its spectrum auction plan 2018–2022.

In December 2018 Canada launched an auction of spectrum at 600 MHz (614–698 MHz).

Bidding began in mid-March, with ISED auctioning the spectrum licences in this band on a technology-neutral basis, and ended in April 2019. Nine companies received one or more regional licences to use the spectrum: Bragg Communications, Freedom Mobile, Iris Technologies, Rogers, SaskTel, TBayTel, TELUS, Vidéotron and Xplornet. The auction raised just over CAD3.47 billion.

Mid-band spectrum at 3500 GHz is expected to be auctioned in 2020, while spectrum at 26 GHz, 28 GHz, 37–40 GHz and 64–71 GHz is expected to be made available for flexible terrestrial use towards the end of 2021.

In June Canada's ISED published a number of documents relating to its 5G plans.

It launched a consultation on the licensing and auction framework for 20 unpaired 10 MHz blocks of spectrum between 3450 MHz and 3650 MHz and on an updated licensing framework for the approximately 34 existing licensees in the 3400–3700 MHz frequency band (which will allow those meeting all existing licence conditions to be issued with flexible-use licenses covering the same geographic area).

Spectrum in the 3400–3450 MHz frequency band (currently used for radar) will be kept under review.

Spectrum from 3650 MHz to 3700 MHz is currently primarily used for fixed point-to-point services and will be kept under review and be subject to a consultation on future use.

Spectrum from 3700 MHz to 4200 MHz is primarily used for fixed phone and internet satellite services and fixed point-to-point back-haul links. ISED intends to hold an auction of the spectrum in 2022, subject to a consultation on mechanisms for sharing the spectrum with existing users.

Following a consultation, ISED also announced its decision with regard to use of mmWave spectrum for 5G. This included the decision to adopt a flexible licensing model for fixed and mobile services in the 26.5 GHz to 27.5 GHz and 27.5 GHz to 28.35 GHz frequency bands, enabling the deployment of fixed or mobile services using a single license (subject to some sharing of the spectrum with satellite users). Only TDD systems will be permitted.

A flexible licensing model is also to be adopted for spectrum in the 37.6 GHz to 40 GHz frequency band, with TDD use only. A decision on use of 37.0 GHz to 37.6 GHz has been deferred to a later date.

ISED also designated the 64 GHz to 71 GHz frequency band as licence-exempt (once technical standards for licence-exempt equipment have been issued).

In addition, Canada is considering plans to release the 1500 MHz, 1600 MHz, 26 GHz, 32 GHz and 80 GHz bands for mobile use, subject to ongoing analysis.

### **Chile (Under-Secretary of Telecommunications (Subtel))**

In mid-2018, Subtel froze current licences in the 3400–3800 MHz band to prepare for future auction (as it deemed coverage and usage of the band was very patchy) and in July 2018, it opened a consultation on use of the 3.4–3.8 GHz and 27.5–28.35 GHz bands for 5G. Subsequently, operators using the spectrum at 3.5 GHz for local fixed-wireless broadband were permitted to continue to do so; the freezing of the current licences for other players has become the subject of a legal complaint.

In February 2019, Subtel announced a tender of 5G spectrum, subject to ongoing consultations about the technical and bidding mechanisms.

In May it launched a further public consultation on use of spectrum for 5G, stating that it planned to tender spectrum in four bands (20 MHz in the 700 MHz band; 30 MHz in the AWS band; 50 MHz in the 3.5 GHz band and 850 MHz in the 28 GHz band). The consultation was scheduled to close in June 2019, with auctions anticipated in Q4 2019.

### **Costa Rica (Superintendencia de Telecomunicaciones (Sutel))**

Costa Rica is expected to launch a study of spectrum for 5G in H2 2019.

### **Colombia (Ministry of Information and Communications Technologies (MinTIC))**

In February 2019, MinTIC issued a call for interest in spectrum allocations in Band E, in particular for optimisation of coverage of 4G networks, including provision of last mile connectivity and urban small cells.

In April 2019, the ICT Ministry announced a call for interest to participate in an auction of spectrum in the 700 MHz (698–806 MHz), 1900 MHz (1865–1867.5/1945–1947.5 MHz) and 2500 MHz (2500–2690 MHz) bands for use for terrestrial mobile services (IMT). It will publish its plan for the spectrum allocation process in the third quarter of 2019.

Also in April 2019, MinTIC also launched a consultation on frequency bands for 5G.

### **Ecuador (Ministerio de Telecomunicaciones y de la Sociedad de la Información (MINTEL))**

In July 2019, MINTEL revealed plans to auction spectrum at 700 MHz and 2.5 GHz for 4G services starting in November 2019 and spectrum at 3.5 GHz for 5G services in 2020. (A proportion of the 3400–3600 MHz band would require refarming.)

The country's national frequency plan also considers releasing spectrum in the AWS band.

### **El Salvador (Superintendence of Electricity and Telecommunications (SIGET))**

The government is planning to auction the 1700 MHz/2100 MHz bands.

In February 2019, the government announced plans to auction spectrum in Bands 2, 4 and 66 for use in the provision of mobile services, with the auction originally due in April 2019. At the time of writing this did not appear to have happened.

### **Mexico (Federal Institute of Telecommunications (IFT))**

The telecom regulator completed an auction of spectrum between 2500 MHz and 2690 MHz in August 2018, with TDD and FDD blocks subsequently awarded to the winning bidders, AT&T and Telefonica. The regulator has stated the spectrum can be used for delivery of 4G and 5G services.

In 2020, Mexico is to auction the 600 MHz (614–698 MHz) band for 5G, following the relocation of digital television services into the lower bands.

In addition, the regulator has been reported in local newspaper *El Economista* to be considering possible auctions of AWS band spectrum (1.7 GHz/2.1 GHz) and unallocated spectrum at 2.5 GHz – potentially in 2019.

IFT is expected to produce a national spectrum plan for 5G services by mid-2019. As an input to this, in April it published the results of its study of spectrum bands for 5G usage, identifying a range of bands that could potentially be used for 5G in Mexico: 600, 700, 2500, and 3500 MHz; 26, 38, 42, 48, and 51 GHz. Spectrum at 3400–3600 MHz would require refarming.

### **Peru (Ministry of Transport and Communications (MTC))**

In August 2018, the Ministry declared the reordering/refarming of spectrum in a number of bands to open up more spectrum for 4G and 5G services. It intends to refarm spectrum in the following bands for the provision of services linked to more advanced mobile technologies (IMT): 452.5–457.5 MHz and 462.5–467.5 MHz, 806–821 MHz and 851–866 MHz, 821–824 MHz and 866–869 MHz, 2500–2692 MHz, 2300–2400 MHz and 3400–3600 MHz. Peru is also understood to be considering a release of spectrum at 3.5 GHz covering the wider 3300–3800 MHz range for 5G services, and spectrum at 24.25–27.5 GHz.

In this context, in late 2018/early 2019 the Ministry of Transport and Communications reviewed the legal validity of an allocation of regional spectrum at 2.5 GHz to Bitel in 2017. In January 2019, it decided that the due process was followed and Bitel would keep the spectrum although it would be subject to the reordering plan underway separately.

In March 2019, a Ministerial Resolution approved the holding of a tender for a single national concession for frequency at 1750–1780 MHz and 2150–2180 MHz (AWS-3 band) and 2300–2330 MHz for the provision of public telecoms services (including 4G and 5G), at a date to be determined.

In June, MTC approved rules to regulate the leasing of under-used spectrum. Operators not meeting usage thresholds will be forced to lease their spectrum to third parties for the provision of services in rural or poor areas.

In July, MTC launched a public consultation on the idea of opening up spectrum in the 3400–3800 MHz frequency band for advanced mobile services and 5G.

## USA (Federal Communications Commission (FCC))

In the USA, any bands already used for mobile service can also be deployed for 5G; FCC doesn't require any particular technology and the choice is driven by carriers. This means multiple historic auctions are relevant for 5G including but not limited to those for spectrum at 2.5 GHz (March 1996), 28 GHz (March 1998 and May 1999) and 39 GHz (May 2000).

FCC is currently undertaking a range of activities with a view to opening up extra spectrum for mobile use.

In 2016, the FCC adopted its Upper Microwave Flexible Use Rules to make spectrum at 28 GHz, upper 37 GHz and 39 GHz available (including for 5G). Then the new Spectrum Frontier order dated 16 November 2017 put in place plans to open up an additional 1.7 GHz of mmWave spectrum in the 24 GHz and 47 GHz bands for flexible terrestrial wireless use. FCC also enabled usage of spectrum between 64 GHz and 71 GHz by unlicensed devices (subject to restrictions). In 2017, the FCC additionally auctioned off the 600 MHz band (the Broadcast Incentive Auction).

In October 2018, FCC decided to alter the licensing structure for the 3.5 GHz (3550–3700 MHz) band, allocated for Citizens Broadband Radio Service. Among other things, it decided to increase the size of licensing areas, extend the length of licence terms and to make them renewable, with a view to making the licences more attractive to 5G investors. CBRS priority licences are not expected to be auctioned until 2020, although unlicensed 'General Authorization Access' of the band is expected to be facilitated within 2019.

It is consulting on adding mobile broadband use to existing (satellite) uses allowable in the 3.7–4.2 GHz spectrum range.

In October 2018, the Commission issued a notice of proposed rule-making that would open up the 5.925–6.425 GHz and 6.425–7.125 GHz bands for unlicensed use, subject to establishing a mechanism to prevent interference with incumbent services. It specifically anticipates – depending upon the part of the spectrum concerned – the use of low or standard power WiFi or variants of LTE for indoor or outdoor use.

The FCC has been running auctions of spectrum in the 24 GHz and 28 GHz bands. The auction of spectrum at 28 GHz (27.5–28.35 GHz) completed in January 2019, with bids totalling more than \$700 million. Thirty-three bidders won 2965 licences.

The auction of spectrum at 24 GHz (24.25–24.45 GHz and 24.75–25.25 GHz) ended in May 2019 raising \$2.02 billion in net bids. Twenty-nine bidders won 2904 licences.

FCC is considering opening up the 4.9 GHz public safety band possibly for more 5G access and to support robotic and drone operations in the future. FCC is formally considering making 3700–4200 MHz mid-band frequencies available for 5G. In May 2018, FCC announced plans to auction the spectrum not already licensed in the 2.5 GHz band (2496–2690 MHz) for additional educational licences. In June 2018, FCC announced that it is also considering making an additional 2.75 GHz of the 26 GHz and 42 GHz bands available for 5G.

In December 2018, FCC announced an incentive auction (Auction 103) covering spectrum at 37 GHz (37.6–38.6 GHz); 39 GHz (38.6–40 GHz) and 47 GHz (47.2–48.2 GHz) in order to free up more spectrum for 5G. Under the incentive auction, existing rights holders in those bands can choose either to relinquish their rights in exchange for a share of the auction revenue or alternatively receive modified licences after the auction consistent with a new band plan and service rules. Auctions for 37 GHz, 39 GHz and 47 GHz bands are planned by the end of 2019. Procedures for reconfiguring the 39 GHz band, enabling existing licensees to relinquish or modify their licences were published in March 2019. Technical guides for bidding procedures were published in April 2019, along with the announcement of a process the Department of Defense to operate on a shared spectrum basis at 37 GHz. Timelines for the reconfiguration of existing rights were published in June 2019.

In July 2019 the FCC announced its decision to enable flexible use of spectrum at 2.5 GHz (2496 MHz to 2690 MHz), making it available for 5G, and ending the requirement to use it for educational purposes.

### **Uruguay (Unidad Reguladora de Servicios de Comunicaciones (URSEC))**

Local press reported in January 2019 that Uruguay plans to auction spectrum for 5G in mid-2019, including spectrum at 600 MHz and 2500 MHz.

In May 2019, Uruguay's regulator authorised ANTEL to deploy mobile services in the 27.5 to 28.35 GHz band (originally licensed to ANTEL for the provision of LMDS services).



## Asia-Pacific

Figure 3: national spectrum positions in the C-band – Asia-Pacific (ITU Region 3)

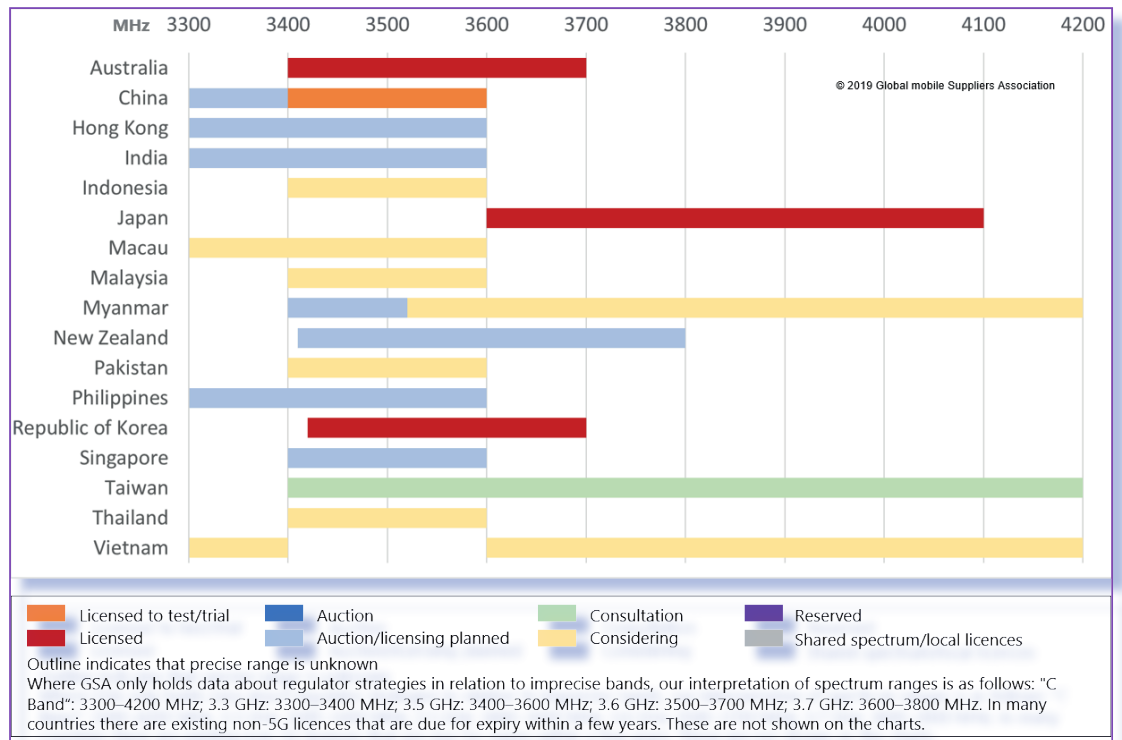
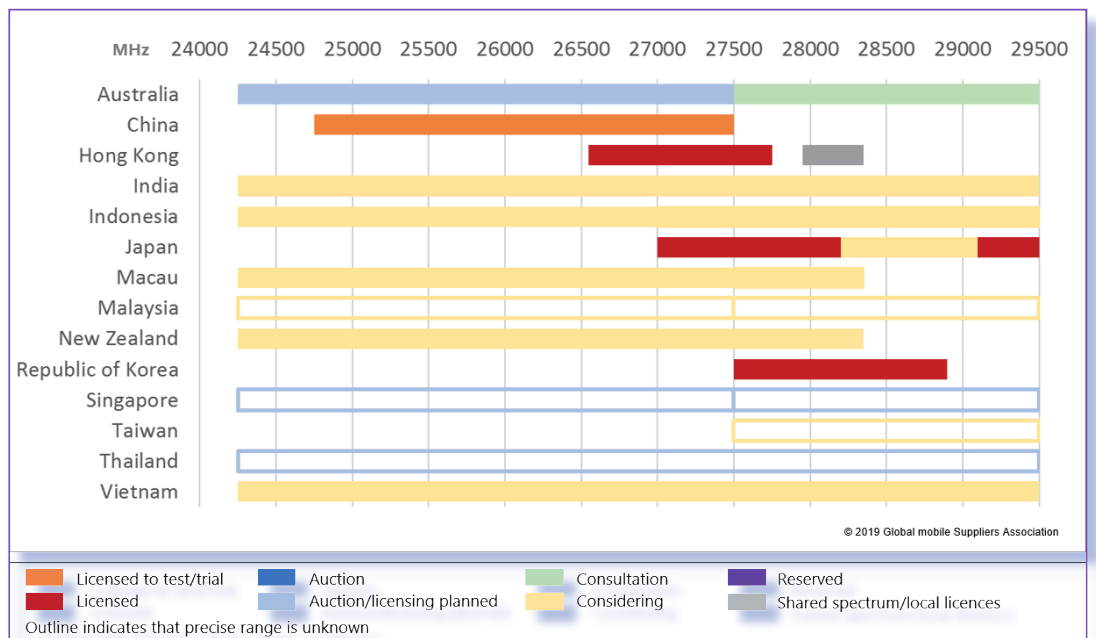


Figure 4: national spectrum positions in the 26 GHz and 28 GHz bands – Asia-Pacific (ITU Region 3)





### Armenia (Public Services Regulatory Commission (PSRC))

In December 2018, PSRC announced a competition between the three existing mobile operators for spectrum at 800 MHz (811–821 MHz and 852–862 MHz), 1700 MHz (1765–1785 MHz) and 1800 MHz (1860–1880MHz), with application procedures beginning in January 2019. The spectrum is being allocated with a view to improving the coverage of the country's LTE and LTE-Advanced networks.

### Australia (Australian Communication and Media Authority (ACMA))

In December 2018, ACMA completed an auction of spectrum in the 3600 MHz band for 5G use, with four companies (Dense Air Australia, Mobile JV, Optus Mobile and Telstra) winning lots.

Following consultations on the use of the 24.25–27.5 GHz (26 GHz) band, in April 2019, ACMA published its planning decisions and preliminary views. It has moved into a replanning stage for this spectrum and proposes its use for the introduction of wireless broadband services. Wide-area licences will be limited to spectrum above 25.1 GHz to ensure coexistence with some satellite and space applications, although a range of apparatus and class licences for a restricted set of applications/use cases may be permitted from 24.25 to 25.1 GHz. Spectrum from 27 to 27.5 GHz may be subject to restrictions to ensure coexistence with NBN satellite uplinks using this frequency range.

ACMA also published a new consultation on use of the 28 GHz (27.5–29.5 GHz) band. Its preferred options for use of the spectrum in this band are point-to-point, fixed wireless and satellite services.

Additionally, in April, it opened up its new five-year spectrum plan for consultation. Subject to this process (ending May 2019), it is considering a number of potential spectrum allocations:

- 26 GHz: auction in Q3/4 2020 (Q1/2 FY 2021), following consultation on recommendations to minister in Q2 2019 (Q4 FY 2018/19)
- 850/900 MHz: configuration options for 900 MHz in 2Q 2019 (4Q FY 2019/2020) then allocation in Q3/4 2020 (Q1/2 FY 2021)
- 1.5 GHz: options paper and planning decision in calendar 2020, then allocation in Q1/2 2022 (FY Q3/4 2021/22)
- 3.4–3.575 GHz: options paper in Q2 2019 (Q4 FY 2018/19), allocation timing to be confirmed
- 28 GHz: planning decision by Q3 2019 (Q1 FY 2019/20) and changed allocations implemented by Q1/2 2021 (FY Q3/4 2020/21).

### **Bangladesh (Bangladesh Telecom Regulatory Commission (BRTC))**

It was reported in local newspaper *The Daily Star* in January 2019 that Bangladesh is preparing to issue 5G licences in 2020.

### **China (Ministry of Industry and Information Technology (MIIT))**

MIIT reserved the 3300–3600 MHz and 4800–5000 MHz bands for 5G services. China is also expected to use the 24.75–27.5 GHz band and the 37–43.5 GHz band and has recently initiated a stakeholder consultation on these bands. It is also considering the use of the 4400–4500 MHz band.

In December 2019, MIIT approved the use of a number of bands for 5G tests by operators, including the 2515–2675 MHz, 3400–3500 MHz, 3500–3600 MHz and 4800–4900 MHz bands.

In June 2019 MIIT awarded 5G service licences to the country's three existing mobile operators, China Mobile, China Telecom, and China Unicom, as well as to a fourth player, China Broadcasting Network.

### **Hong Kong (Office of the Communications Authority (OFCA))**

In December 2018, OFCA completed an auction of 50 MHz of spectrum in the 900 MHz band and 70 MHz of spectrum in the 1800 MHz band. Each of the four bidders – China Mobile Hong Kong, HKT, Hutchison Telephone and SmarTone – won spectrum at 1800 MHz and 900 MHz.

In the same month, OFCA announced that Hong Kong would be making available spectrum at 3.3–3.4 GHz (indoor use only), 3.4–3.6 GHz (indoor and outdoor use, with spectrum available from April 2020) and 4.84–4.92 GHz (indoor and outdoor use) by way of auctions, on a technology-neutral basis. The application process for the auctions was launched in July 2019, with applications due during September 2019.

In March 2019, OFCA announced that, following an administrative process, 400 MHz of spectrum within the 26.55–27.75 GHz range had been offered to each of three network operators – China Mobile Hong Kong Ltd, Hong Kong Telecommunications and SmarTone Mobile Communications – for the provision of public mobile services (including 5G).

In July 2019, it announced that it would be making 400 MHz in the 27.95–28.35 GHz range available for Localised Wireless Broadband Licences (using 5G or other advanced mobile technologies) on a geographic-sharing basis. It opened up applications for assignment of the shared spectrum later the same month.

OFCA has also stated plans to assign spectrum at 617–698 MHz and 703–803 MHz for indoor mobile services in 2020, with the spectrum available from 2021 at the earliest.

### **India (Telecom Regulatory Authority of India (TRAI))**

In January 2018, TRAI held an Open House discussion on ‘Auction of Spectrum in 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, 2500 MHz, 3300–3400 MHz and 3400–3600 MHz bands’. In March 2018, India’s Telecom Department asked incumbents to free spectrum in the 3300–3400 MHz band for 5G by 30 September 2018.

India also created a 5G High Level Forum to formulate strategy on 5G. The Forum released its recommendation on 5G spectrum in August 2018 which included the following spectrum bands: 617–698 MHz, 698–803 MHz, 1427–1518 MHz, 3300–3600 MHz, 3600–3700 MHz, 24.25–27.5 GHz, 27.5–29.5 GHz, 29.5–31.3 GHz, 31.8–33.4 GHz and 37–43.5 GHz. India’s Telecom Department is now preparing an action plan based on this recommendation.

Also in August, TRAI released more detailed recommendations regarding the release of spectrum in the lower bands: 700 MHz (703–748 MHz/758–803 MHz), 800 MHz (824–844 MHz/869–889 MHz), 900 MHz (890–915 MHz/935–960 MHz), 1800 MHz (1710–1785 MHz/1805–1880 MHz), 2100 MHz (1920–1980 MHz/2110–2170 MHz), 2300 MHz (2300–2400 MHz), 2500 MHz (2500–2690 MHz), 3300–3400 MHz and 3400–3600 MHz covering regions, spectrum blocks and reserve prices. Timelines for all these are yet to be confirmed, but are likely to happen in the second half of 2019.

In May 2019 local press reports indicated that the government could auction 4G and 5G spectrum by September/October 2019.

In October 2018, the Indian government opened up spectrum in the 5150–5250 MHz, 5250–5350 MHz and 5470–5875 MHz bands for unlicensed (low power) wireless use, including use by wireless access points, fixed point-to-point connections and portable and mobile client devices.

### **Indonesia (Ministry of Communications and Informatics of Indonesia (BRTI))**

In January 2019, the Ministry announced it was restructuring spectrum allocations in the 800 MHz and 900 MHz bands to give operators contiguous blocks of spectrum with a view to facilitate refarming from 2G to 3G or 4G and enable improved coverage for 4G services.

Initial indications from the Ministry for Communications and Informatics were that Indonesia would license 5G spectrum by 2022. Speaking in April 2019 however, Ministry representatives gave an updated view that spectrum could possibly be issued in Indonesia in 2020. The specific frequency bands are expected to be set after WRC in October 2019. The bands under consideration for allocation include 3500 MHz, 24.25–27 GHz and 27–29.5 GHz .

### **Japan (Ministry of Internal Affairs and Communications (MIC))**

In February 2019, several of Japan's operators (KDDI and Okinawa Cellular, Softbank and Rakuten) applied to be allocated 5G frequencies. Final decisions on allocations were issued in April 2019, as follows.

- NTT DoCoMo: 3600–3700 MHz, 4500–4600 MHz, 27.4–27.8 GHz
- KDDI/Okinawa Cellular: 3700–3800 MHz, 4000–4100 MHz and 27.8–28.2 GHz
- Softbank: 3900–4000 MHz and 29.1–29.5 GHz
- Rakuten Mobile: 3800–3900 MHz and 27.0–27.4 GHz

The operators must start services within each prefecture within two years and must each meet coverage targets.

Meanwhile, spectrum at 28.2–29.1 GHz is under consideration for 'local' 5G service provision and might not be allocated to national mobile operators, and spectrum at 4800–4900 MHz has been reserved for 5G but not yet licensed.

### **Macau (Macau Posts and Telecommunications (CTT))**

In December 2018, Macau's CTT stated plans to make the following spectrum bands available for public land mobile telecommunications, in preparation for the launch of 5G services: 3300–3400 MHz (indoor use only), 3400–3600 MHz (subject to preventing interference with satellite communications), 4830–4930 MHz, 24.25–27.5 GHz and 27.5–28.35 GHz.

### **Malaysia (Malaysia Communications and Multimedia Commission (MCMC))**

The MCMC has formed a 5G Task Group which will make a recommendation on spectrum for 5G to the Malaysian Government. The Group is focusing on the 3.5 GHz, 26 and 28 GHz ranges.

In July 2019, MCMC launched a public inquiry to collate industry views on proposals for the timeframe, technical matters and spectrum fees for the

allocation of the 700 MHz, 2300 MHz and 2600 MHz bands in Malaysia, with a view to improving the use of the spectrum for the provision of mobile broadband services.

It is intending a tender for the spectrum at 700 MHz (four blocks of paired 2x10 MHz spectrum) in the 703–743/750–798 MHz ranges. The process is expected to start in Q4 2019 and complete in 2Q 2020, with the spectrum available for mobile broadband from Q3 2020 at the earliest.

It is planning to restructure the spectrum at 2300 MHz, currently allocated for regional licences, into national spectrum lots of 10 MHz and to allocate them through a tendering process. The process is expected to start in Q4 2019 and complete in 3Q 2020, with the spectrum available from Q4 2020 at the earliest.

MCMC is also planning to reassign spectrum in the 2600 MHz band based on current actual use (as various players share their spectrum with others). The process is expected to start in Q4 2019 and complete in 2Q 2020, with the spectrum available for mobile broadband from Q3 2020 at the earliest.

#### **Myanmar (Ministry of Transport and Communications, Posts and Telecommunications Department)**

In June 2019, the Ministry launched a consultation based on its initial IMT and 5G spectrum roadmap. Its plan envisages releasing over 350 MHz of spectrum in 2020 (in the 2300 MHz [2300–2390 MHz] n40 band, the 2600 MHz [2500–2570 and 2620–2690 MHz TDD] n41 band, and 3500 MHz [3400–3520 MHz] n77/n78 bands); spectrum at 700 MHz n28 in 2021; at 1500 MHz in 2020 (subject to demand); plus extra spectrum at 3500 MHz in 2023 (subject to guard band requirements); plus spectrum at 4800 MHz and mmWave in 2024 subject to demand; and spectrum at 600 MHz in 2025 or beyond. It also envisages 850 MHz/E-GSM 900 MHz replanning in 2023.

The spectrum can be used for 4G/5G deployments.

#### **Nepal (Nepal Telecommunications Authority (NTA))**

Following legal action by the existing spectrum licence holder, the Supreme Court in January 2019 ordered NTA to postpone an auction of unused spectrum at 900/1800/2100 MHz pending the outcome of legal proceedings.

### **New Zealand (Ministry of Business, Innovation and Employment; Radio Spectrum Management; and Commerce Commission)**

According to the Radio Spectrum Management's 'Road map to 5G' in New Zealand, the range between 3410 and 3690 MHz could be considered for 5G post-October 2022. The ranges 24.25–28.35 GHz, 1427–1518 MHz band (L Band) and the 600 MHz band are also to be considered for 5G use.

In February 2019, the government announced that the 3.5 GHz band (3410–3800 MHz) will be allocated for regional and national 5G use, with rights to use the spectrum scheduled for allocation in 2020 and available for use from 2022 (once existing usage rights held by regional FWA operators have expired). The auction process will be the subject of consultation during 2019. It also stated it would next focus on allocation of rights to use 5G in higher millimetre wave bands.

### **Pakistan (Pakistan Telecommunication Authority (PTA))**

PTA is formally considering the use of the 3500 MHz band for 5G services. Meanwhile the government is expected to announce plans for licence renewals for Telenor and Jazz (Warid) and Zong, as these all expire in 2019, along with plans to issue extra spectrum.

### **Philippines (Department of Information and Communication Technology)**

Having formally named the winner of its competition to create a new major player (NMP) in the country's telecoms market, the Mislattel consortium, the regulator is undertaking a number of policy reviews including analysis of the potential to recall underused spectrum to support either the NMP or other new market entrants. The NMP has already been promised spectrum in a variety of bands (700 MHz, 850 MHz, 2010 MHz, 2100 MHz, 2500 MHz, 3300 MHz, 3500 MHz and 10.5 GHz).

### **Singapore (Infocomm Media Development Authority (IMDA))**

In May 2019, IMDA launched a new public consultation on the appropriate regulatory frameworks and policies for 5G, to facilitate 5G network rollout by 2020 and to identify innovative 5G applications and services for Singapore. IMDA plans to allocate the 3.5 GHz (3400–3600 MHz) and the 26 GHz and 28 GHz bands for 5G in the initial tranche of spectrum allocation following a call for proposals expected later in 2019. (The 3.5 GHz band, currently used for satellite, is expected to be available from 2021.) IMDA is also considering the following bands for future 5G deployments: 700 MHz, 1427–1518 MHz, 2.1 GHz, 2.5 GHz and 4.5 GHz.



It followed this in the same month by launching a public consultation on its plans for enterprise and public mobile use of the 800 MHz, 1900 MHz and 2100 MHz spectrum bands. It is consulting on allocating spectrum at 800 MHz and 1800 MHz for enterprise data services, and enabling use of spectrum at 2100 MHz for 4G services (the spectrum currently being used for 3G).

### **Republic of Korea (Ministry of Science and ICT)**

The Republic of Korea held its first 5G auction in the 3.5 GHz and 28 GHz bands on 15 June 2018. SK Telecom and KT each acquired 100 MHz in the 3.5 GHz band, the maximum amount allowed per operator, while LG Uplus won 80 MHz; in the 28 MHz band, each operator won 800 MHz.

### **Taiwan (The National Communications Commission (NCC))**

NCC has opened a public consultation on the allocation of spectrum in the 3400–3600 MHz, 3600–3800 MHz and 3800–4200 MHz bands for 5G in 2020. It is also formally considering the 28 GHz band.

### **Thailand (National Broadcasting and Telecommunications Commission (NBTC))**

NBTC concluded an auction of spectrum at 1800 MHz and 900 MHz in August 2018, though not all blocks sold. A second-round auction of spectrum at 900 MHz was completed in October 2018. A further auction of spectrum at 1800 MHz is expected in 2019.

In November 2018, NBTC passed a regulation recalling unused spectrum in the 1500 MHz, 2300 MHz and 2600 MHz bands, with a view to reallocation via auction for provision of 5G services.

In January 2019, NBTC also set the date of 31 October 2019 for the termination of 2G services in Thailand, with a view to freeing up the spectrum for 5G services.

In June 2019, the NBTC licensed spectrum in the 700 MHz band to three operators, each valued at 18.81 billion baht (around 610 USD). TrueMove, DTAC, and AIS each received 10x10 MHz of 703–713 MHz/758–768 MHz, 713–723 MHz/768–778 MHz and 723–733 MHz/778–788 MHz, respectively. The term of licence will be 15 years with 10 years of instalments from Oct 15, 2020.

Subsequent sales of spectrum at 2600 MHz, 26 GHz and 28 GHz are expected before the end of 2019 and a sale of additional spectrum at 700 MHz is due to follow in Q2 2020.



## Vietnam (Ministry of Information and Communications)

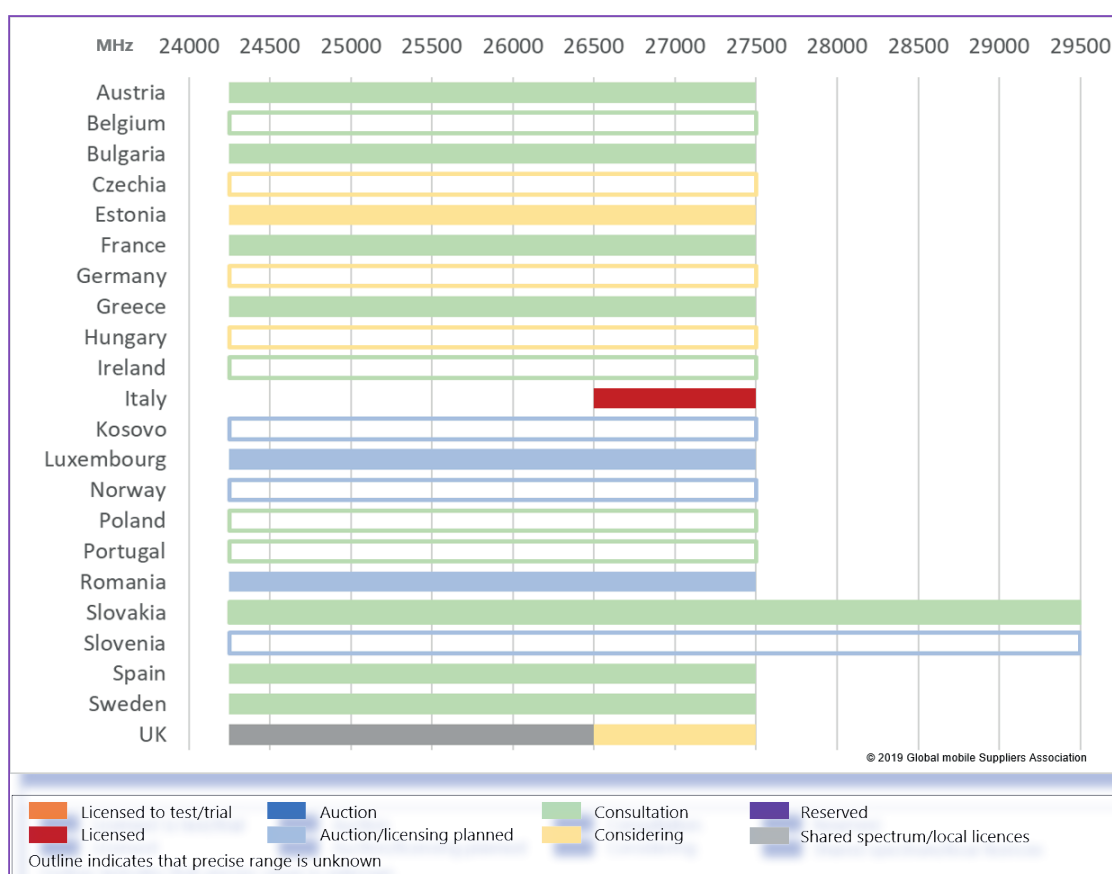
The Ministry of Information and Communications is formally considering auctioning the 700 MHz and 2600 MHz bands, which will, in principle, be technology neutral, in the coming year. Specifically for 5G, the Ministry has stated that the 24.25–27.5 GHz and 27–43.5 GHz bands are of interest and (whole or partly) could be made available for 5G services pending international developments. For 5G mid-bands, Vietnam is considering parts of the 3300–3400 MHz and the 3600–3800 MHz bands, while protecting the FSS earth stations, and the 3800–4200 MHz band, as well as 4400–5000 MHz. In January 2019, it licensed Viettel to begin field trials in three spectrum bands: 2575–2615 MHz, 3700–3800 MHz and 26.5–27.5 GHz. It also stated it would be issuing a new 4G frequency licence and reviewing when to turn off 2G or 3G services.

## Europe

Figure 5: National spectrum positions in the C-band – CEPT (ITU Region 1)



Figure 6: National spectrum positions in the 26 GHz and 28 GHz bands – CEPT (ITU Region 1)



## European Union (European Commission)

The European Union has taken a number of decisions designed to promote availability of new spectrum bands for 5G. Recent decisions include:

In January 2019 the European Commission adopted an *Amending Implementation Decision* to harmonise radio spectrum at 3400–3800 MHz (the 3.6 GHz band) for future use with 5G. The band had already been harmonised for use for wireless broadband services. The new *Decision* updated the technical conditions to support 5G deployment, although the spectrum should be allocated nationally on a technology- and service-neutral basis.

In May 2019, the European Commission adopted an *Implementing Decision* to harmonise radio spectrum in the 24.25–27.5 GHz (26 GHz) band, enabling Member States to set common technical conditions for use of the band and open it up for use (with 5G in mind, but on a technology- and service-neutral basis).

*The EU Electronics (New Framework)* sets a deadline of December 31, 2020 for the granting of spectrum at 3400–3800 MHz and 24.25–27.5 GHz for 5G service provision.

The EU has also set the (non-binding) target that each Member State should ensure availability of spectrum at 700 MHz by 2020 (or 2022 in some circumstances).

#### **Albania (Authority of Electronic and Postal Communications (AKEP))**

In April 2019, the Albanian regulator completed the tender process for paired spectrum at 800 MHz (792–862 MHz). Vodafone Albania was confirmed as the winner of the spectrum in April 2019.

#### **Austria (Austrian Regulatory Authority for Broadcasting and Telecommunications (RTR); Telekom-Control-Commission (TKK))**

In early March 2019, RTR announced the results of an auction of spectrum in the 3400–3800 MHz frequency band. The awards were technology neutral, but the spectrum lots were designed to attract interest for deployment of 5G services and to encourage participation by new regional players. Each of the country's three mobile operators won spectrum, along with four regional bidders.

RTR has also published a non-binding schedule (subject to re-evaluation) for subsequent auctions of spectrum in the following bands: 700 MHz, 1500 MHz (core band), 2100 MHz, 2300 MHz and 1500 MHz (expansion band) in spring 2020.

In June, RTR launched a consultation to collate views on possible plans for spectrum at 2300 MHz and 26 GHz (24.25 GHz to 27.5 GHz).

#### **Belgium (Belgian Institute for Post and Telecommunications (BIPT))**

In 2018, BIPT announced plans to auction the 700 MHz, 1400 MHz and 3600 MHz bands for 5G, according to the following indicative timelines:

- 700 MHz, 3400–3800 MHz, 1500 MHz (SDL) in 2019
- 26 GHz from 2021
- 31.8–33.4 GHz and 40.5–43.5 GHz from 2022 to 2027.

BIPT had also been planning allocation of 2G and 3G spectrum in the 900 MHz, 1800 MHz, 2 GHz and 2.6 GHz bands, possibly in 2019. Consultations regarding these various auctions/bands are underway.

However, an interview with the Telecom Minister in *De Tijd* in January 2019 suggested plans for auctions have been postponed until 2020, due to delays in getting laws through the Consultation Committee, which coordinates federal government and federal state policy.

In May 2019, BIPT launched a public consultation on the use of spectrum at 26 GHz for 5G, designed to consider market demand, migration of existing users and the future regulatory framework.

### **Bulgaria (Communications Regulation Commission (CRC))**

CRC has launched a public consultation on the use of the 3400–3600 MHz and 3600–3800 MHz bands for 5G services before 2020. In November 2018, it also opened a public consultation on the use of free spectrum in the 2000 MHz and 2600 MHz bands.

It additionally opened a public consultation on a draft decision to adopt a new radio spectrum regulatory policy. Key elements include redistribution of spectrum at 1800 MHz to ensure more efficient usage; allocation of 2x15 MHz of spectrum at 2000 MHz for network expansion, upgrade and development; opening up spectrum at 3400–3800 MHz and defining conditions for releasing at least 1 GHz between 24.25–27.5 GHz to support the introduction of 5G networks; release of additional spectrum at 800 MHz for civilian use (it is currently partly used for security services); allocation of 700 MHz after end of use by broadcasters and security services; and creation of 2600 MHz, 3600 MHz and 1427–1517 MHz frequency bands.

### **Croatia (Croatian Regulatory Agency for Network Services (HAKOM))**

In January 2019, HAKOM announced a call for applications to use frequency in the range 2500–2690 MHz – spectrum in Bands 7 and 38 – for broadband wireless access services. Three operators submitted applications: Tele2, A1 and Croatian Telekom. In March 2019 all three were awarded spectrum in Band 7.

### **Cyprus (Republic of Cyprus Ministry of Transport, Communications and Works (MCW))**

In April 2019, MCW issued licences for 5G testing in the 3400–3800 MHz range to three operators (Cyta, MTN and Primetel). The licensing process for longer-term 5G network deployment and operation is expected to complete in the last quarter of 2019.

Meanwhile MCW is also running an auction (date to be confirmed) of spectrum at 800 MHz (2x10 MHz) and 2600 MHz (2x20 MHz FDD and 1x15 MHz TDD) for the ‘establishment of electronic networks for the provision of electronic services’. In April 2019, Cablenet Communications Systems and Primetel were shortlisted for inclusion in the auction list.

### **Czechia (Czech Communications Office (CTU))**

In 2017, CTU awarded frequencies in the 3600–3800 MHz band to four operators for high-speed data networks.

It is now preparing for a multiband auction of spectrum including (2x30 MHz) in the 700 MHz band (703–733/758–788 MHz) and 190 MHz of spectrum in the 3400 MHz band (3410–3600 MHz) for mobile broadband services in the second half of 2019. CTU aims to attract a fourth mobile operator and has designed the auction rules accordingly (2x10 MHz in the 700 MHz band is reserved for a new entrant, together with time-limited national roaming on the existing operators' networks during its network build-out). In June 2019, it launched a consultation on rules for the tender.

It has also stated its future intention to issue spectrum at 26 GHz for 5G.

### **Denmark (Danish Energy Agency)**

In March 2019, Denmark completed an auction of spectrum at 700 MHz, 700 MHz SDL, 900 MHz and 2300 MHz. Three operators (Hi3G, TDC and TT-N [the infrastructure company jointly owned by Telia and Telenor]) were awarded spectrum on a service and technology-neutral basis.

### **Estonia (Ministry of Economic Affairs and Communications)**

In January 2019, Estonia's Ministry signed a regulation establishing the procedures for an auction of three equal lots of spectrum at 3600 MHz (3410–3800 MHz), suitable for 5G. The auction was originally expected in spring 2019, although the process is currently the subject of legal challenge.

It also published a 5G spectrum roadmap in March 2019, which sets out plans for an auction of spectrum in the range 694–790 MHz in the first half of 2020. It also intends to open a public consultation on the use of spectrum in the range 24.25–27.5 GHz and has noted the potential to use 40.5–43.5 GHz and 66–71 GHz for 5G.

### **Finland (Finnish communications regulator (FICORA))**

In October 2018, FICORA completed an auction of spectrum in the 3500 MHz frequency band (3410–3800 MHz), useable for 5G. Licences for the right to use 130 MHz of frequency were awarded to each of DNA Finland, Elisa and Telia Finland.

## France (Regulatory Authority for Electronic Communications and Posts (ARCEP))

In October 2018, ARCEP launched a consultation on procedures for allocating (through auction or other means) spectrum at 1400 MHz, 3400–3800 MHz and 26 GHz, with the aim of achieving commercial 5G deployment in at least one major city by 2020.

At the end of March 2019 applications were closed for requests to run 5G trials at 26 GHz. It subsequently revealed that it had received 15 applications; results will be announced in September 2019.

In June 2019, ARCEP set the end of December 2022 as the deadline for new authorisations to use L-band spectrum at 1.5 GHz (1427–1517 MHz) with a view to opening the band for 5G (in line with the European target to do so by 2023).

In July 2019 ARCEP launched a consultation on the terms and conditions for allocation of 310 MHz of spectrum in the 3490 MHz to 3800 MHz band. These include 5G coverage commitments (though not necessarily using the spectrum being auctioned, which is awarded on a technology neutral basis).

Separately, in October 2018, ARCEP also called for applications for reallocation of spectrum in the 900 MHz, 1800 MHz and 2.1 GHz bands currently used for 2G, 3G and 4G (and for which authorisations expire between 2021 and 2024), with a view to improving 4G coverage. It received applications from Bouygues Telecom, Free Mobile, Orange and SFR and agreed that all met the criteria for reallocation. In November 2018, licences were extended subject to meeting new coverage and reception quality obligations and to rebalancing of spectrum ownership in the 900 MHz and 2100 MHz bands between the operators.

In May 2019, ARCEP opened up the possibility for private use of TDD spectrum at 2.6 GHz (2575–2615 MHz) for very-high-speed mobile networks. Then in July, it launched a consultation on the technical rules for coordinating all these networks.

## Germany (Federal Network Agency, Bundesnetzagentur)

Germany auctioned spectrum at 700 MHz for mobile broadband in 2015; the spectrum was approved for use in July 2019.

In June 2019, Bundesnetzagentur completed an auction of spectrum in the 2000 MHz (1920–1980 MHz/2110–2170 MHz) and 3400–3700 MHz bands for 5G services. Four companies participated in the auction bidding a total of

Euro 6.5 billion. All of them gained spectrum: Drillisch Netz gained 2x10 MHz at 2000 MHz and 50 MHz at 3600 MHz.; Telefónica Germany gained 2x10 MHz at 2000 MHz and 70 MHz at 3600 MHz; Telekom Deutschland gained 2x20 MHz at 2000 MHz and 90 MHz at 3600 MHz; Vodafone gained 2x20 MHz at 2000 MHz and 90 MHz at 3600 MHz.

The winners will be expected to meet coverage and throughput targets.

Bundesnetzagentur has also drawn up application procedures for use of the 3700–3800 MHz band for local and regional purposes and has stated it will be drawing up an application procedure for using the 26 GHz band (for local or regional 5G services or improving rural mobile coverage).

### **Greece (Hellenic Telecommunications and Post Commission (EETT))**

EETT announced that on 2 February 2017, the procedure for granting of the ‘Rights of Use for Radiofrequencies’ in the band 24.5–26.5 GHz had been completed and three operators were granted frequencies to use for fixed wireless access services.

In October 2018, EETT published a review of frequency bands for 5G which set out the following timetables:

- 700 MHz (694–790 MHz): competitive procedure for granting rights in July 2020, spectrum available for mobile/fixed communications networks in December 2020.
- 1500 MHz (1427–1517 SDL): consultation planned.
- 2100 MHz (1920–1980/2110–2170 MHz): consultation planned for the unused portion of this band and the portion for which licences expire in 2021.
- 2300 MHz (2300–2400 MHz, 100 MHz TDD): public consultation on appropriate use by end 2019.
- 3600 MHz (3400–3600 MHz): public consultation on licensing expected by the end of 2019 (some later press reports have suggested licensing is possible in 2019).
- 26 GHz (24.25–27.5 GHz): public consultation about appropriate use end 2019/early 2020.



### Hungary (National Media and Infocommunications Authority)

The National Media and Infocommunications Authority announced the timetable and final spectrum plan for a multi-band auction in July 2019. Spectrum available includes:

- 5x(2x5) MHz paired at 700 MHz (708–733/763–788 MHz)
- 3x(2x5) MHz paired at 2100 MHz (1965–1980/2155–2170 MHz)
- 15 MHz at 2600 MHz (unpaired from 2600 MHz to 2615 MHz)
- 310 MHz at 3600 MHz (unpaired from 3490 MHz to 3800 MHz).

It is available for 5G and other wireless broadband services.

Applications to participate in the auction open in August 2019, with bidding expected in September.

Separately, the Authority has also been formally considering plans to auction spectrum at 26 GHz.

In December 2018, Vodafone Hungary and Magyar Telekom paid to extend their licences at 2100 MHz until 2027; Magyar Telekom uses the spectrum for its 3G services, and while Vodafone uses the spectrum for 3G and 4G, Vodafone Hungary noted that it might use it for 5G in the future.

### Ireland (Commission for Communications Regulation (ComReg))

In May 2017, ComReg allocated slices of the 3600 MHz band for broadband (including 5G) services. The Commission also published a consultation regarding the distribution of spectrum in the 26 GHz band. The new 26 GHz National Block Licences are likely to be restricted to point-to-point (P2P) links and licensees will not be permitted to offer mobile services using the spectrum.

In June 2019, it launched a consultation on a proposed multi-band spectrum auction covering:

- 2x30 MHz at 700 MHz (with speed and coverage obligations)
- 2x45 MHz and subsequently 2x60 MHz in the 2100 MHz band (with coverage obligations)
- 100 MHz at 2300 MHz (with coverage obligations)
- 190 MHz in the 2600 MHz band, including 2x70 MHz FDD and 50 MHz TDD (with coverage obligations).

The spectrum would be for mobile and wireless broadband services, allocated on a technology- and service-neutral basis.

### Italy (Autorità per le Garanzie nelle Comunicazioni (AGCOM))

In September/early October 2018, Italy ran an auction of spectrum in the following '5G pioneer' bands: 1000 MHz at 26 GHz; 200 MHz at 3700 MHz; and 75 MHz at 700 MHz. Five operators (Fastweb, Iliad Italia, TIM Italy, Vodafone Italy and Wind Tre) were awarded spectrum.

### Kosovo (Regulatory Authority for Electronic Communications (ARKEP))

In November 2018, the Kosovan regulator opened a consultation on process for distribution and usage of spectrum at 800 MHz, 900 MHz and 1800 MHz for mobile services.

In May 2019, ARKEP published plans to licence and open up new bands. The plan included:

- renewing the spectrum licences already held by IPKO and Kosovo Telecom at 900 MHz and 1800 MHz.
- issuing licences to use the new spectrum bands including spectrum at 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2600 MHz, 3400–3800 MHz and 26 GHz.
- issuing licences to use spectrum at 800 MHz, 900 MHz, 1800 MHz, 2100 MHz and 2600 MHz in an auction in the second half of 2019.
- issuing licences to use spectrum at 3400–3800 MHz and possibly 700 MHz and 26 GHz in an auction after 2022.

### Latvia (Public Utilities Commission)

In December 2017, SPRK announced that LMT had won spectrum in the 3400–3450 MHz and 3650–3700 MHz bands for 5G services.

In September 2018, it auctioned 50 MHz of spectrum between 3550 and 3600 MHz for 5G services.

In January 2019, SPRK announced it had cancelled Lattelecom's right to use spectrum in the 1427–1452 MHz and 1492–1517 MHz ranges (used for fixed services), with effect from the start of 2021, with a view to redistributing the spectrum range 1427–1517 MHz for mobile services including 5G.

### Lithuania Communications Regulatory Authority (RRT)

RRT launched a public consultation on the use of spectrum in the 3400–3800 MHz and 3800–4200 MHz frequency ranges for 5G in April 2018. Its consultations continued throughout 2018 and into 2019 with a focus on the 3400–3800 MHz range. The latest stage of the consultation closed in April 2019.

In September 2018, the government authorised the release of 700 MHz for mobile services; RRT will now work towards auctioning the frequencies before 2022.

#### **Luxembourg (Luxembourg Telecommunications Regulation Authority (ILR))**

In line with its 5G strategy, published in November 2018, in May 2019, Luxembourg launched a public consultation on the use of 700 MHz (703–733/758–788 MHz) for 5G, as well as on the use of spectrum in the 3400–3800 MHz range, with a view to allocating licences in the second half of 2019. Spectrum from 3420–3700 MHz is intended for deployment of national networks. Spectrum from 3700–3800 MHz (which will be the subject of a separate consultation) is intended to be licensed for local applications.

It has also stated its intention to allocate spectrum at 24.25–27.5 GHz in the second half of 2020.

#### **Macedonia (Agency for Electronic Communications (AEK))**

In December 2018, AEK announced its intent to issue spectrum at 2100 MHz (1965–1980 MHz/2155–2170 MHz) for use in public mobile/fixed communications networks, including IMT systems. Expressions of interest were due by 20 Jan 2019. Three companies expressed interest (Makedonski Telekom, VIP and Yellow Mobile), so AEK ruled in January 2019 it would hold a tender for a single licence to use the spectrum (timeline to be confirmed).

#### **Malta (Malta Communications Authority)**

Malta plans to open up 700 MHz band to mobile services from mid-2021.

#### **Moldova (National Regulatory Agency for Electronic Communications and Information Technology (ANRCETI))**

In August 2018, the Moldovan regulator launched a call for expressions of interest in an auction of spectrum in Bands 1, 8, 20, 33, 34, 38, 42 and 43. The deadline for expressing interest to participate was 28 September 2018. The eventual auction date was not published.

#### **Netherlands (Authority for Consumers and Markets (ACM) and Ministry of Economic Affairs)**

June 2019 saw the publication of the Netherlands' updated spectrum plan. The government intends to auction spectrum at 700 MHz (703–733 MHz and 758–788 MHz; available from 2020), 1400 MHz (L-Band 1452–1492 MHz;

available from 2020), 2100 MHz (1920–1980 MHz and 2110–2170 MHz; with spectrum available from 2021 following the expiration of existing licences); and 3500 MHz.

The 700 MHz, 1400 MHz and 2100 MHz bands are scheduled to be auctioned at the beginning of 2020.

The government intends to make spectrum at 3500–3700 MHz available from September 2022. Spectrum at 3400–3450 MHz and 3750–3800 MHz is intended to be made available for local use from 2026. Spectrum at 3450–3500 MHz and 3700–3750 MHz is already used and currently protected for national security reasons.

The Netherlands' Digital Connectivity Action Plan foresees the use of spectrum at 26 GHz either for a very large number of local permits, or for shared use, from 2020. Stakeholder consultations are underway.

### **Norway (Norwegian Communications Authority (Nkom))**

In February 2019, Nkom published a spectrum roadmap for mobile communications and 5G. This included a preliminary award schedule for spectrum across a variety of bands: 450 MHz (2019 for 2020 activation); 700 MHz (2019); Band 67 700 MHz SDL (2020); L-Band 1500 MHz (2020); 2100 MHz (2019); 2300 MHz (2020 for 2023 activation); 2600 MHz (2020 for 2023 activation); 3400–3800 MHz (2020 for 2023 activation); and 26 GHz (2020 for 2023 activation). Licence activation dates may be delayed after the auctions until the expiration dates of existing licences.

In April 2019, Nkom completed an auction of frequency in the 700 MHz and 900 MHz bands for offshore private use only. Winners were Telenor Maritime, Tampnet, and Equinor Energy.

In May 2019, Nkom awarded ICE Norge 2x5 MHz of spectrum at 450 MHz (452.5–457.5 MHz/462.5–467.5 MHz) to use for mobile broadband services from 2020. It was the only applicant.

In June 2019, NKOM ran an auction of spectrum at 700 MHz and 2100 MHz for use in the provision of mobile services (specifically including 5G). Ice, Telia and Telenor Norge all won spectrum; Ice in both bands; Telia and Telenor in the 700 MHz band. They collectively paid just over NOK735 million. The 2x30 MHz of spectrum at 700 MHz will be useable from November 2019, whilst the 2x15 MHz of spectrum at 2.1 GHz was useable immediately.

In June 2019, Nkom launched a consultation on frequency resources for mobile communications and 5G. This proposed postponing auctions of a number of bands – originally scheduled for 2019 and 2020, until mid-2021 at the earliest.

It is considering a joint assignment of spectrum in three bands in 2021:

- the 2300 MHz to 2400 MHz band (Nkom is considering local/regional permits in this band)
- 2600 MHz (2500 MHz to 2690 MHz)
- 3600 MHz (Nkom is considering local/regional permits in this band).

Meanwhile, spectrum at 700 MHz SDL (738–758 MHz), 1500 MHz SDL (1427–1518 MHz) and 26 GHz (24.25–27.50 GHz), originally scheduled for 2020, now look unlikely to be assigned before 2022.

#### **Poland (President of the Office of Electronic Communications (UKE))**

The Polish regulator held a consultation on the allocation of the following 5G spectrum: 700 MHz, 3.5 GHz, 3.7 GHz and 26 GHz, which ended in August 2018. In September 2018, UKE said it would be publishing an update of plans in due course.

In December 2018, Poland applied to the EC for more time to open up the 700 MHz spectrum band, requesting a delay from 2020 to 2022.

#### **Portugal (National Communications Authority (ANACOM))**

ANACOM is currently holding a public consultation on a proposed spectrum auction of various bands for 5G: 700 MHz, 450 MHz, 900 MHz, 1500 MHz, 1800 MHz, 2.1 GHz, 2.6 GHz, 3.6 GHz and 26 GHz. In June 2018, the regulator approved a roadmap for the distribution of 700 MHz (694–790 MHz) spectrum for future 5G wireless services. According to the regulator, the band, which is currently used for digital terrestrial television services, will be freed up by 30 June 2020.

#### **Romania (National Authority for Management and Regulation in Communications (ANCOM))**

In June 2019 ANCOM published plans for the auction of spectrum across multiple bands. It intends (subject to consultation) to run an auction by the end of October 2019 of the following spectrum:

- 700 MHz: 2x30 MHz (FDD) and 1x15 MHz (SDL)
- 800 MHz: 2x5 MHz (FDD)
- 1500 MHz: 1x40 MHz SDL
- 2600 MHz: 2x40 MHz FDD
- 3400–3800 MHz: 90 MHz TDD valid from 2020 to 2025 (to operate alongside existing licensees in this range); then 400 MHz TDD from 2026.

The awards are expected to be finalised by the end of 2019 and some of the spectrum will be useable from the start of 2020.

ANCOM has also previously stated plans (subject to consultation) to auction spectrum at 26 GHz (24.25–27.5 GHz) in 2021.

### **Russia (The Minister of Digital Development, Communications and Mass Communications)**

The Russian Ministry of Communication has previously awarded test licences for 5G trials in the 3400–3800 MHz and 25.25–29.5 GHz bands. Then in December 2018, the State Commission on Radio Frequencies allocated regional licences for use of frequencies at 25.25 GHz and 27.5 GHz for various 5G tests. It additionally invited interested parties to apply to use frequencies in the 4800–4990 MHz and 27.1–27.5 GHz bands for pilot 5G projects.

However, Russia has yet to sort out long-term 5G spectrum licensing formally. Operators MegaFon and Rostelecom have been looking at the potential to deploy 5G in the 3400–3600 MHz and 26 GHz bands.

Speaking in September 2018, the Minister stated that ‘by the end of the year [2018] it is planned to develop a concept for the creation and development of 5G/IMT-2020 networks in Russia’ and ‘in 2019, to determine radio frequency bands and approve the development plan for 5G networks.’

### **Serbia (Ministry of Trade, Tourism and Telecommunications)**

Speaking at an industry event, Serbia’s Assistant Minister for Trade indicated she expects 5G auctions at the end of 2019 or early 2020.

### **Slovakia (Office for Regulation of Electronic Communications and Postal Services (RU))**

RU has awarded 3600–3800 MHz licences for wireless broadband that are suitable for LTE and 5G. The regulator also launched a consultation on the 26 GHz and 29 GHz bands for 5G.

In May 2018, RU launched a call for tenders for various regional licences to use spectrum in the 10 GHz band for the provision of public fixed wireless access communications. This followed on from a call in January 2018 covering other areas without active services. Multiple regional licences exist.

In June 2019, RU announced that it was proceeding with an auction of spectrum at 700 MHz. The auction is expected to happen before the end of 2019. In the meantime it is preparing a consultation about the auction procedures.



### **Slovenia (Agency for Communication Networks and Services)**

Slovenia has launched a public consultation for the allocation of spectrum in the 700 MHz band for 4G and 5G services.

In May 2019, Slovenia published its national spectrum strategy, with request for comments. Following the consultation it will revise and seek governmental approval for its plans which include auctions within the 2019/2020 timetable of spectrum at 700 MHz, 1400 MHz (1427–1517 MHz), 2100 MHz, 60 MHz in the 2300 MHz band, 3540–3800 MHz and 26 GHz. A portion of the 2300 MHz and spectrum at 3400–3500 MHz is expected to be set aside for local use (including for private use). Decisions on the allocations are expected by June 2020. In the 2021/2022 timetable, it envisages tenders for spectrum in other bands identified during WRC-19, any unallocated spectrum from the 2019/20 auctions and for spectrum at 28 GHz and 32 GHz for fixed wireless broadband access.

### **Spain (Ministry of Energy, Tourism and Digital Agenda (MINETAD))**

In July 2018, Spain ran an auction of the 3.6–3.8 GHz spectrum band for use for 5G services. A total of 200 MHz was auctioned, with three operators winning spectrum. Orange España separately gained spectrum at 3.5 GHz in an auction in 2016.

In June 2019, Spain's Council of Ministers approved a royal decree to release spectrum at 700 MHz (694–790 MHz) for the provision of 5G services, with the process due to be completed by June 2020.

A public tender of the spectrum is expected before that date.

### **Sweden (Swedish Post and Telecom Authority (PTS))**

An auction for spectrum in the 700 MHz band, to be used for mobile broadband services was held in December 2018, with two companies, Telia and Net4Mobility winning spectrum.

PTS plans to auction spectrum at 2.3 GHz (2300–2380 MHz) and 3.5 GHz (3400–3720 MHz) for mobile broadband and 5G services in 2019. In October 2018, PTS asked for unused municipal licences in the 3.5 GHz band to be returned. In February 2019, PTS announced a consultation about allocation of spectrum at 2300 MHz and 3500 MHz, covering aspects such as blocks, auction format, technical rules and spectrum limits. It launched another in June 2019 covering the auction rules. PTS also intends to enable local permits for the use of 3720–3800 MHz (these will be managed through a separate administrative process). PTS has also initiated consultations on the demand for 5G frequencies in the 24.25–27.5 GHz bands.



## Switzerland (Federal Communications Commission)

In July 2018, the Federal Communications Commission launched an invitation to tender for spectrum in the 700 MHz, 1400 MHz, 2600 MHz and 3500–3800 MHz bands. While suitable for 5G, they were auctioned on a technology-neutral basis in January 2019.

The results of the auction were announced in early February 2019, with three operators receiving spectrum: Salt, Sunrise and Swisscom each received 700 MHz FDD spectrum; Sunrise received 700 MHz SDL spectrum; all three were awarded 1400 MHz SDL spectrum and spectrum in the 3500–3800 MHz range.

Some blocks of spectrum across the spectrum bands remained unsold; none of the TDD spectrum at 2600 MHz was sold.

## UK (Office of Communications (Ofcom))

Ofcom issued an update to its 5G strategy, saying that would continue its work to free radio spectrum in the 700 MHz, 3.6–3.8 GHz and 26 GHz bands (as well as considering whether spectrum in the 66–71 GHz bands may be viable) for 5G. In March 2018, Ofcom allocated spectrum in the 3.4 GHz band (3410–3480 MHz and 3500–3580 MHz) for 5G.

Ofcom has additionally made licence-exempt spectrum available under a technology-neutral regime in the 57–71 GHz band, which could be used for future 5G services.

In December 2018, Ofcom stated plans to auction two spectrum bands for mobile services in late 2019/early 2020: 80 MHz in the 700 MHz band and 120 MHz in the 3600–3800 MHz band (having awarded spectrum between 3400 and 3600 MHz in April 2018), with coverage obligations. The plans were subject to consultation, which ended in mid-March 2019.

It has also consulted on plans to allow spectrum sharing at 1800 MHz (1781.7–1785 MHz paired with 1876.7–1880 MHz), 2300 MHz (2390–2400 MHz) and 3800–4200 MHz, in locations where the spectrum is not being used by licensed users (including military, satellite and mobile operators), to support creation of private networks, deployment of FWA networks and improving of mobile coverage.

In June 2019, Ofcom launched a consultation on plans to defragment spectrum in the 3400–3800 MHz band.

Following consultations, in July 2019, Ofcom announced plans to initiate spectrum sharing with localised licensing of key spectrum bands. Its aim is to open up use of the spectrum to private network operators such as enterprises and utilities. The spectrum that will be available through local licences includes:

- 3800–4200 MHz
- 1781.7–1785 MHz/1876.7–1880 MHz) (called 1800 MHz shared spectrum by Ofcom)
- 2390–2400 MHz (called 2300 MHz shared spectrum).

The spectrum will be made available on a coordinated first-come, first-served basis. Ofcom indicated that localised licenses can be applied for immediately.

Ofcom has also decided to enable localised access to spectrum in the 26 GHz band (24.25–26.5 GHz) available on a shared-spectrum basis, but only for indoor use. (Spectrum in the 26.5–27.5 GHz range is used by the military. Ofcom will continue to review possible ways of making this spectrum available in the future.)

Finally, Ofcom announced that it will enable access to spectrum that is already licensed to operators but which is not being used or planned to be used within a particular area for three years, subject to the proviso that the new user must not cause interference. This covers all spectrum in the bands listed below (although Ofcom accepts usage is likely to be limited to remote usage). Shared Access Licences will be available for the 1800 MHz, 2300 MHz and lower 26 GHz bands from the end of 2019, but these licences will ultimately include the 800 MHz, 900 MHz, 1400 MHz, 1900 MHz, 2100 MHz, 2600 MHz and 3400 MHz bands too.

### **Ukraine (National Commission for the State Regulation of Communications and Informatization (NCCR))**

NCCR extended WiMAX operator Aero Telecom's rights to use spectrum for multiservice radio access by five years to 2025. The spectrum at 3.6 GHz is potentially suitable for 5G.

In May 2019, NCCR was quoted in the press as having indicated 2020 as a possible date for future 5G spectrum sales.

## Middle East and Africa

Figure 7: National spectrum positions in the C-band – Middle East and Africa (ITU Region 1)

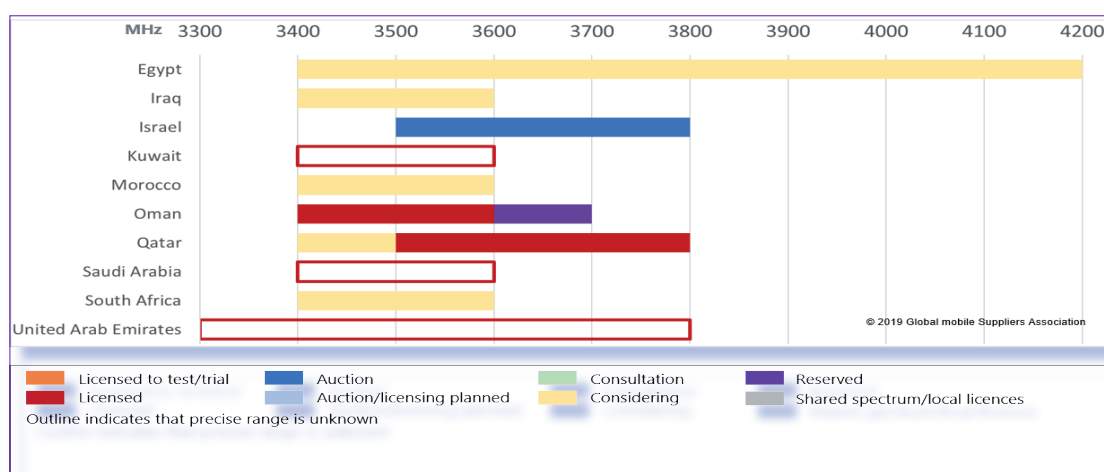
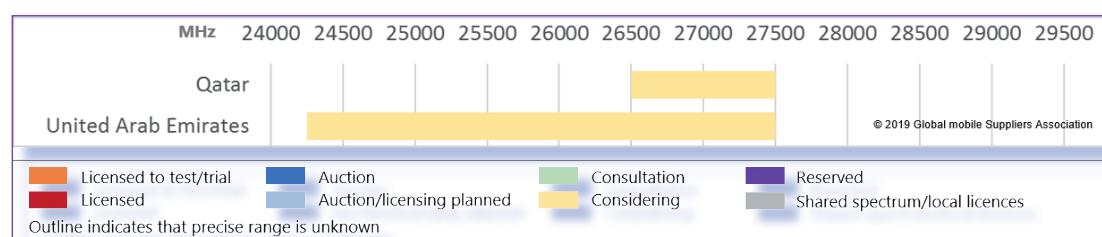


Figure 8: National spectrum positions in the 26 GHz and 28 GHz bands – Middle East and Africa (ITU Region 1)



### Bahrain (Telecommunications Regulatory Authority (TRA))

In August 2018, TRA launched a consultation on the award of spectrum for mobile broadband at 800 MHz (60 MHz between 791–821 MHz and 832–862 MHz, available as 2x30 MHz of paired spectrum) and 2600 MHz (2500–2570 MHz and 2620–2690 MHz, which could be offered as paired or unpaired spectrum). The consultation closed in October 2018.

It launched a second consultation in March 2019 covering the same FDD spectrum, but with only a TDD option for the 2550–2690 MHz spectrum. Its provisional timetable for the release of the spectrum envisaged announcement of the awards in June 2019. Three lots were intended to be made available, offered to the three existing licensees, each to receive 2x10MHz at 800 MHz plus 40 MHz at 2600 MHz (TDD), with a remaining block of 20 MHz at 2600 MHz to be issued by auction. The spectrum awards were expected to be technology neutral. The consultation closed in April 2019.

The regulator reported in July 2019 that the spectrum at 800 MHz and 2600 MHz had been allocated, but did not indicate which operator won the 20 MHz of 2600 MHz spectrum available through auction.

Bahrain's operators launched fixed wireless access and mobile 5G services in June/July 2019. GSA has not been able to identify which spectrum bands have been used, although TRA does indicate that the frequencies used for 5G are the same frequencies that have been used for WiMAX and 4G services.

### **Burkina Faso (Ministry of Digital Economy Development and Posts)**

On 5 December 2018, the Council of Ministers approved plans submitted by the Ministry of Digital Economy Development and Posts to enable technology-neutral licences in the country and to convert all existing licences to technology-neutral licences.

### **Cyprus (Department of Electronic Communications)**

In July 2018, the Ministry of Transport, Communications and Projects, Department of Electronic Communications published its national route map for 700 MHz. It intends to auction the spectrum for use by wireless broadband electronic communications services once the spectrum has been cleared (it is currently used for broadcasting). A public consultation on release of the spectrum is due in September 2019, with an auction due in June 2020.

In October 2018, a call was issued for applications to participate in an auction of spectrum in the 800 MHz (2x10 MHz) and 2600 MHz bands (2x20 MHz FDD and 1x15 MHz TDD) for the establishment and operation of electronic communications networks in Cyprus. The Ministry issued the bidders' package in November 2018 with an application deadline of 18 December 2018, with an auction to follow in 2019.

### **Egypt (National Telecommunication Regulatory Authority (NTRA))**

NTRA is formally considering using 3400–4200 MHz for IMT. In November 2018, a spokesperson for the NTRA indicated he expected spectrum for 5G to be assigned by the start of 2020.

### **Ghana (National Communications Authority (NCA))**

In December 2018, NCA issued spectrum at 800 MHz following a tender process (not an auction). 2x5 MHz was awarded to Vodafone Ghana. Three lots had been made available. There were two bidders, but only one lot was awarded.

### **Iran (Communications Regulatory Authority (CRA))**

Reports in the *Tehran Times* in April 2019 indicated that Iran's CRA is in the process of work to allocate bandwidth for 5G and enable the deployment of 5G services.

### **Iraq (Communications and Media Commission)**

Iraq has been undertaking a review of spectrum allocated to FWA services. It launched an initial public consultation in December 2018, with a second expected to follow. It has been examining the use of spectrum at 450 MHz, 1500 MHz, 2300 MHz, 2600 MHz and 3500 MHz, taking into account the need for spectrum for 4G and 5G services.

### **Israel (Ministry of Communication)**

Israel launched a tender of 5G spectrum in July 2019 including spectrum in the 700 MHz band (2x30 MHz FDD), 2600 MHz band (2x60 MHz FDD) and 3500–3800 MHz band (300 MHz TDD). 100 MHz of spectrum is reserved for a new player. The tender includes obligations for 5G technology deployment. The winners are expected to be announced before the end of 2019. Commercial launches are expected from 2020.

### **Kuwait (Communication and Information Technology Regulatory Authority (CITRA))**

In May 2019, CITRA confirmed licences to use spectrum at 3500 MHz had been issued to enable the launch of 5G networks, following completion of testing.

### **Mauritania (L'Autorité de Régulation (ART))**

In October 2018, ART issued an invitation to tender for licences to provide 2G, 3G and 4G services (three 4G licences and a single 2G/3G/4G licence to encourage a new entrant). The call for bids was relaunched in February 2019, with bids due in March 2019. The bid deadline has subsequently been extended to May 2019.

### **Morocco (National Agency for the legalisation of communications (ANRD))**

Morocco is considering using the 3400–3600 MHz band for IMT.

### **Mozambique (Instituto Nacional das Comunicacoes de Mozambique (INCM))**

In November 2018, Mozambique completed auctions of spectrum at 800 MHz, 1800 MHz and 2600 (FDD) MHz, to be used for 4G services. Only the spectrum at 800 MHz attracted bids.

### **Oman (Telecommunications Regulatory Authority (TRA))**

According to reports in *Muscat Daily*, Oman allocated spectrum in December 2018 to Omantel (3400–3500 MHz) and Ooredoo (3500–3600 MHz) for operating 5G networks, with spectrum between 3600 MHz and 3700 MHz reserved for a new operator (due to be announced in 2019). The government aims for the introduction of 5G services before 2020.

### **Qatar (Communications Regulatory Authority (CRA))**

CRA is considering auctioning the 700 MHz band, 3500 MHz band (3400–3600 MHz) and 26 GHz band (26.5–27.5 GHz) for 5G mobile services. The 700 MHz frequency band would be deployed to accommodate the demand of the service providers and for the applications of the public protection and disaster relief (PPDR).

On 2 January 2019, Qatar's Ministry of Communications announced that it had granted licences to Ooredoo and Vodafone to operate 5G networks (starting in January 2019), granting each operator 100 MHz of spectrum in the 3500–3800 MHz range. The companies committed to deploying 5G networks in populated areas, all major highways and venues associated with the 2022 FIFA World Cup, by the end of 2020. The Ministry also harmonised the operators' coverage and deployment agreements for 2G, 3G and 4G networks and rolled all previous spectrum licences into new single spectrum licences/authorisations.

### **Saudi Arabia (Communications and Information Technology Commission (Saudi Arabia) (CITC))**

CITC allocated a total of 80 MHz of spectrum across the 700 MHz, 800 MHz and 1800 MHz bands to STC, Zain and Etihad Etisalat (Mobily) in an auction held on 11 February 2018. The bands are suitable for next-generation wireless high-speed data services across Saudi Arabia.

In January 2019, CITC announced that it had awarded licences at 2300 MHz and 2600 MHz to the country's existing mobile operators. STC has reported it was awarded spectrum at 2300 MHz. Zain announced that it had received spectrum at 2600 MHz. CITC reported that Mobily was also awarded spectrum (band to be confirmed). The spectrum can be used for 4G or 5G services.

This was followed in March 2019 with an announcement that CITIC had awarded spectrum at 3.5 GHz following an auction. The regulator did not provide further details, although Zain has subsequently confirmed it was awarded spectrum.



## South Africa (Independent Communications Authority of South Africa (ICASA))

ICASA held its first 5G forum meeting to discuss how to implement 5G in the country in 2017. The regulator plans to auction the 825–830 MHz and 870–875 MHz bands in 2019. Public hearings regarding the draft IMT850 Radio Frequency Spectrum Assignment Plan (RFSAP) for the frequency bands 825 MHz to 830 MHz and 870 MHz to 875 MHz were held in early September 2018.

A public announcement at the ITU's Telecom World Conference in Durban in September 2018 by ICASA's president indicated plans to license 700 MHz, 800 MHz and 2.6 GHz for mobile services, though no detailed timetable has yet been announced. In October 2018, as part of a deal to end a legal dispute and to enable the country to move forward with licensing, ICASA revoked historic notices issued in 2016, calling for applications for licences to provide mobile broadband FWA services using these spectrum bands.

The Department of Telecommunications and Postal Services has also said it is likely that spectrum in the 3.5 GHz band will be licensed for 5G, but licensing is not likely until after WRC-19.

In October 2018, Telecoms Minister Cwele promised 4G auctions by April 2019 and 5G auctions in 2020.

## Tanzania (Tanzania Communications Regulatory Authority)

In June 2018, Tanzania held an APT 700 MHz band auction which was aimed at promotion, enhancement and facilitation of innovation for new ICT services and technologies to be deployed in the band. The licences were technology and service neutral.

At the time of the auction, the Tanzania Communications Regulatory Authority also indicated its future intention to assign 40 MHz of 2300 MHz TDD spectrum and 2x15 MHz of 2600 FDD spectrum in the 2018/19 period.

## UAE (Telecommunications Regulatory Authority (TRA))

TRA is considering deployment of 5G in the following bands: 1427–1518 MHz, 3300–3800 MHz and 24.25–27.5 GHz. In addition, the 40 GHz range will be considered for 5G beyond 2020.

In November 2018, a TRA spokesperson stated that it had issued licences to use 100 MHz of spectrum between 3300 MHz and 3800 MHz to both Etisalat and Du for 5G FWA projects, in advance of making 5G generally available commercially after decisions on spectrum allocations are made at WRC-19.

## Completed 5G spectrum auctions and allocations

Table 4 lists the key 5G auctions/allocations that have already taken place (including those for technology-neutral licences or those dedicated for mobile/wireless broadband services). It excludes news about recent auctions, allocations, reallocations or renewals focused exclusively on use for 2G, 3G or 4G services.

*Table 4: Recent 5G and 5G-suitable (e.g. technology neutral) spectrum awards and allocations (2015 onwards)*

Region/ country	Spectrum bands	Licensing basis (e.g. exclu- sive 5G, mobile broadband etc.)	Auction/ award date
Albania	800 MHz	Land mobile services	March 2019
Australia	3575–3700 MHz	5G	December 2018
Austria	3410–3800 MHz	Technology neutral	March 2019
Bahrain	791–821/832–862 MHz and 2550– 2690 MHz TDD	Technology neutral	July 2019
Canada	614–698 MHz	Technology neutral	April 2019
Croatia	2500–2690 MHz	Broadband wireless access	March 2019
Czechia	3600–3800 MHz	High-speed mobile data services	July 2017
Denmark	700 MHz, 700 MHz SDL, 900 MHz, 2300 MHz	Technology and service neutral	March 2019
Finland	3410–3800 MHz	5G	October 2018
Germany	700 MHz 1920–1980 MHz/2110–2170 MHz and 3400– 3700 MHz	Mobile broadband 5G	2015 (spectrum available from 2019) June 2019
Ghana	800 MHz	Mobile services	December 2018
Greece	24.5–26.5 GHz	Fixed wireless access	2017
Hong Kong	900 MHz and 1800 MHz 26.55–27.75 GHz	Public mobile telecom services Public mobile and fixed wireless services (specifically including 5G)	December 2018 March 2019
Ireland	3410–3435 MHz and 3475–3800 MHz	Mobile broadband including 5G	2017
Italy	700 MHz 3600–3800 MHz and 26 GHz	5G 5G	September 2018 October 2018
Japan	3600–4100 MHz; 4500–4600 MHz; 27.0–28.2 GHz; 29.1–29.5 GHz	5G	April 2019
Kuwait	3500 MHz	5G	May 2019

Region/ country	Spectrum bands	Licensing basis (e.g. exclu- sive 5G, mobile broadband etc.)	Auction/ award date
Latvia	3400–3450 MHz and 3650–3700 MHz  3550–3600 MHz  3500–3550 MHz	5G  5G  Electronic communications	2017  September 2018  Rights extended May 2019
Mexico	2500–2690 MHz (TDD and FDD blocks)	4G and 5G	August 2018
Norway	900 MHz  450 MHz  700 MHz, 2100 MHz	Mobile services  Mobile broadband  Mobile broadband and 5G	2017  May 2019  June 2019
Oman	3400–3600 MHz allocated, 3600– 3800 MHz set aside for new entrant	5G	December 2018
Qatar	200 MHz within 3500–3800 MHz	5G	January 2019
Republic of Korea	3420–3700 MHz and 26.5–28.9 GHz	5G	June 2018
Saudi Arabia	700 MHz, 800 MHz, 1800 MHz  2300 MHz and 2600 MHz  3500 MHz	Next-generation wireless high- speed data services  4G and 5G  4G and 5G	2018  January 2019  March 2019
Slovakia	3600–3800 MHz	Wireless broadband (including LTE and 5G)	2017
Spain	3.5 GHz  3600–3800 MHz	Mobile broadband services  5G	2016  July 2018
Sweden	700 MHz	Mobile broadband services; technology and service neutral	December 2018
Switzerland	700 MHz, 1400 MHz, 3500–3600 MHz, 3600–3800 MHz	Technology neutral	February 2019
Tanzania	700 MHz	Technology and service neutral	June 2018
Thailand	850 MHz, 1800 MHz  900 MHz  700 MHz	Digital infrastructure  Digital infrastructure  Technology neutral	August 2018 (not all blocks sold)  October 2018  June 2019
UAE	Allocated two lots of 100 MHz in 3300– 3800 MHz range to enable investment	5G	2018

Region/ country	Spectrum bands	Licensing basis (e.g. exclu- sive 5G, mobile broadband etc.)	Auction/ award date
UK	3400 MHz  3800–4200 MHz; 1800 MHz (1781.7– 1785/1876.7–1880 MHz), 2300 MHz (2390–2400 MHz); 24.25–26.6 GHz (indoor usage only)	5G  Allocated for localised shared spectrum licences (technology neutral)	2018  July 2019
Uruguay	27.5–28.35	Mobile services	May 2019
USA*	600 MHz  28 GHz  24 GHz	Technology neutral  Technology neutral  Technology neutral	2017  January 2019  May 2019

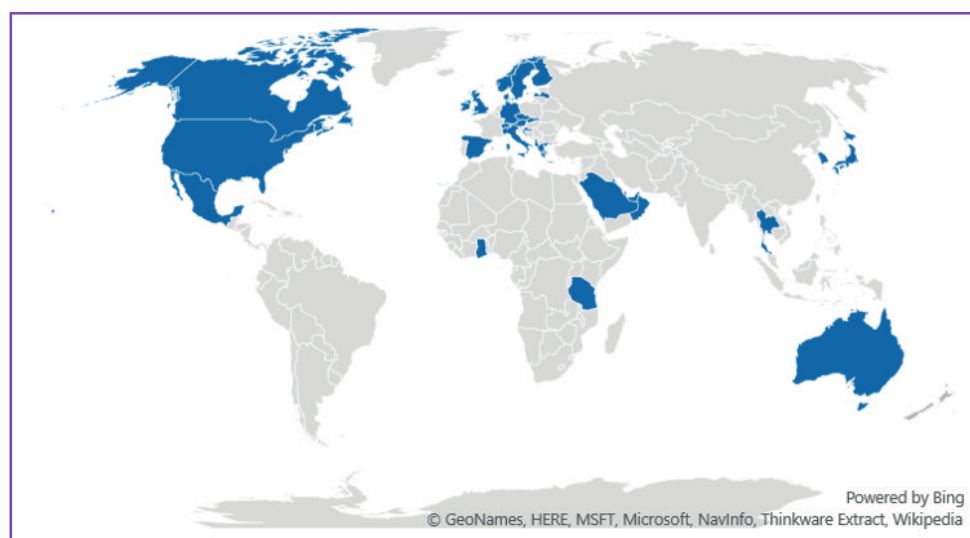
\* Note that due to the typically technology-neutral status of licences in the USA, multiple historic auctions are relevant for 5G including 2.5 GHz (March 1996), 28 GHz (March 1998 and May 1999) and 39 GHz (May 2000) and others. See: <https://www.fcc.gov/auctions> for full details.

*Figure 9: Countries with recently completed auctions, tenders or allocations of 5G or technology neutral spectrum*

## Planned 5G auctions and their dates

Thirty-nine countries have announced formal (date-specified) plans for allocating 5G-suitable frequencies between now and end-2021 (including technology-neutral licences, or licences for mobile broadband services). The details are shown in the table below.

*Table 5: Confirmed 5G and 5G-relevant (e.g. technology neutral) auctions/allocations and their dates 2019 to 2021 (excludes test/interim licences)*



Region/ country	Spectrum bands	Licensing basis (exclusive 5G, mobile broadband)	Auction/ award date
Argentina	738–748/793–803 MHz, 1745–1770/2145–2170 MHz, and three regional blocks of spectrum at 1800 MHz in the ranges 1880–1905 MHz and 1960–1985 MHz	Public or private, regional or local ICT services	2019
Australia	24.25–27.25 GHz  850/900 MHz	Wireless broadband  Wireless broadband	Q3/4 2020 / Q1/2 ACMA FY2020/21  Q3/4 2020 / Q1/2 ACMA FY2020/21
Austria	700 MHz, 1500 MHz, 2100 MHz	5G	Q1 2020
Belgium	700 MHz, 3400–3800 MHz, 1500 MHz (SDL)	5G	2019 (possibly 2020)
Brazil	2300–2400 MHz, 3300– 3600 MHz  700 MHz	Technology neutral  Technology neutral	Q1 2020  Provisionally 2020
Colombia	700 MHz, 1900 MHz and 2600 MHz  E-Band	Technology neutral  Last-mile connectivity and urban small cells	Q4 2019 – calls for interest open
Cyprus	700 MHz  800 MHz and 2600 MHz	Wireless broadband  Electronic communications networks	2020  Application deadline passed; auction 2019
Czechia	700 MHz; 3500 MHz	Wireless broadband service	2019 (700 MHz to be released 2020)
Ecuador	3500 MHz	5G	2020
El Salvador	Bands 2, 4 and 66	Mobile services	2019
Estonia	3600 MHz (3410–3800 MHz)  694–790 MHz	5G  5G	Originally spring 2019; currently the subject of legal challenge  First half 2020
France	3490–3800 MHz	Technology neutral	2020
Greece	700 MHz	5G	2020
Hong Kong	3300–3400 MHz, 3400– 3600 MHz, 4830–4930 MHz  27.95–28.35 GHz  617–698 and 703–803 MHz	Technology neutral  Shared spectrum/localised licensing  Indoor mobile	Application process opened July 2019  Applications opened July 2019  By 2020

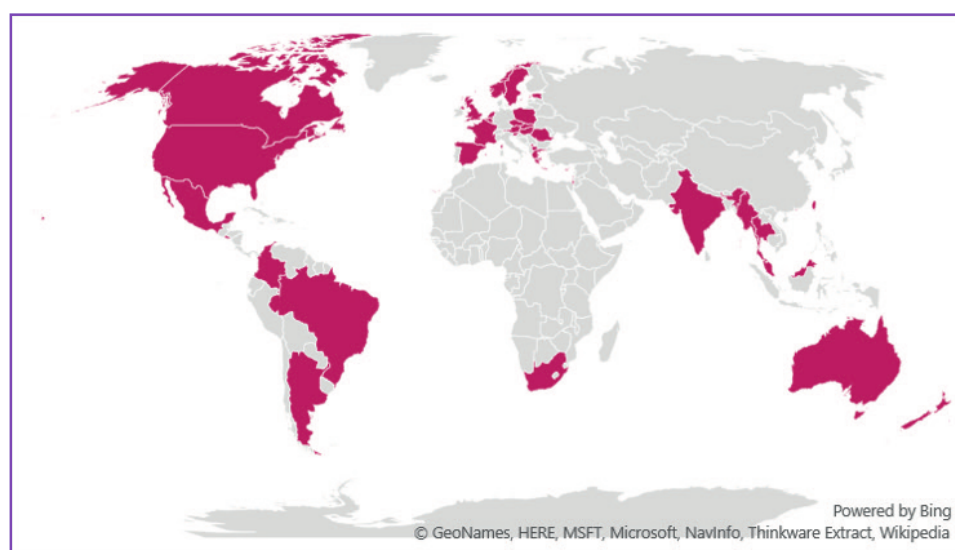
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frequencies  
between now and  
end-2021 (including  
technology-  
neutral licences,  
or licences for  
mobile broadband  
services).*

Region/ country	Spectrum bands	Licensing basis (exclusive 5G, mobile broadband)	Auction/ award date
Hungary	700 MHz (708–733/763–788 MHz); 2100 MHz (1965–1980/2155–2170 MHz); 2600 MHz (unpaired from 2600 MHz to 2615 MHz); 3600 MHz (unpaired from 3490 MHz to 3800 MHz).	Existing networks and 5G	September 2019
India	700 MHz; 3300–3600 MHz and possibly other bands	Technology neutral	During 2019
Israel	700 MHz, 2600 MHz, 3500–3800 MHz	5G	Underway
Kosovo	800 MHz, 900 MHz, 1800 MHz, 2100 MHz and 2600 MHz  3400–3800 and possibly 700 MHz and 26 GHz	Technology neutral Technology neutral	2H 2019 After 2022
Luxembourg	694–790 MHz and 3400–3800 MHz  24.25–27.5 GHz	5G	2H 2019  2H 2020
Macedonia	1965–1980 MHz (2155–2170 MHz)	Public mobile/fixed communications networks	Expressions of interest in Jan 2019; tender to follow
Malaysia	700 MHz (703–743/758–798 MHz); 2300 MHz (2300–2390 MHz)	Mobile broadband	H2 2019 for 2020 spectrum availability
Mexico	600 MHz	5G	2020
Myanmar	2300 MHz (2300–2390 MHz) n40 band, 2600 MHz (2500–2570 and 2620–2690 MHz TDD) n41 band and 3500 MHz (3400–3520 MHz) n77/ n78 bands)  700 MHz n28	4G and 5G 4G and 5G	2020 2021
Netherlands	700 MHz, 1400 MHz, 2100 MHz	4G and 5G	Early 2020
New Zealand	3410–3800 MHz	5G	2020 for use from late 2022
Norway	2300 MHz, 2600 MHz, 3400–3800 MHz  Band 67 700 MHz SDL; L-Band 1500 MHz; 26 GHz	Mobile comms and 5G Mobile comms and 5G	2021 After 2021
Poland	700 MHz	5G	2020
Romania	700 MHz, 800 MHz, 1500 MHz, 3400–3800 MHz  26 GHz	5G 5G	2019 2021
Singapore	3500 MHz, 26 GHz, 28 GHz	5G	Call for proposals late 2019



Region/ country	Spectrum bands	Licensing basis (exclusive 5G, mobile broadband)	Auction/ award date
Slovakia	700 MHz (694–790 MHz)	Mobile services including 5G	H2 2019
Slovenia	700 MHz, 1400 MHz (1427–1517 MHz), 2100 MHz, 60 MHz in the 2300 MHz band, 3540–3800 MHz and 26 GHz.  Minimum of 20 MHz at 2300 MHz and spectrum from 3400–3500 MHz  28 GHz and 32 GHz	National mobile services  Local mobile services (including for private use)Fixed wireless broadband access	June 2020  June 2020  2021/2022
South Africa	825–830 MHz and 870–875 MHz	IMT	2019
Spain	700 MHz	5G	Due for completion in June 2020
Sweden	2300–2380 MHz and 3400–3720 MHz; 3720– 3800 MHz reserved for local permits	Mobile broadband and 5G	2019
Taiwan	3400 MHz, 3600 MHz, 28 GHz	5G	2020
Thailand	1800 MHz (blocks unsold in August 2018 auction) 2600 MHz, 26 GHz, 28 GHz  700 MHz (additional)	Digital infrastructure  Technology neutral  Technology neutral	2019  Q4 2019  Q2 2020
UK	700 MHz and 3600–3800 MHz	Mobile services	Late 2019/early 2020
USA	37 GHz, 39 GHz, 47 GHz  3.5 GHz CBRS priority access licences	Technology neutral  Technology neutral	2019  2020

Figure 10: Countries with confirmed (timetable specified) forthcoming 5G (or technology-neutral) spectrum auctions, tenders or allocations 2019–2020



## Summary

As the widespread commercial introduction of 5G approaches, the number of 5G spectrum-related initiatives by telecom regulators around the world is growing rapidly. As many as 21 more relevant auctions/tenders/allocations in different bands are scheduled to complete in 2019. At least 24 other additional 5G-relevant auctions/tenders/allocations are planned by the end of 2020 (with multiple auctions in some countries). With many other countries still to set out their 5G licensing strategies, more will follow in 2022 and 2023. GSA will track and report on progress in future updates of this report.

## About GSA

GSA reports are compiled from data stored in the GSA Analyser for Mobile Broadband Devices/Data (GAMBoD) database, which is a GSA Member and Associate benefit. For more information on accessing the GSA GAMBoD database please contact GSA at [info@gsacom.com](mailto:info@gsacom.com)

GSA (the Global mobile Suppliers Association) is a not-for-profit industry organisation representing companies across the worldwide mobile ecosystem engaged in the supply of infrastructure, semiconductors, test equipment, devices, applications and mobile support services.

GSA actively promotes the 3GPP technology road-map – 3G, 4G, 5G – and is a single source of information resource for industry reports and market intelligence. GSA Members drive the GSA agenda and define the communications and development strategy for the Association.

Membership of GSA is open to any supplier of products; systems or services related to the mobile industry and brings many benefits including access to the GAMBoD and NTS database. The range of benefits includes enhanced discussion, networking and influencing opportunities on the key industry topics, and unique promotional/visibility opportunities for your company name, capabilities, positioning and messages. More details can be found at <https://gsacom.com/gsa-membership/>

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