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FINAL REPORT FOR CTIA

5G MID-BAND SPECTRUM GLOBAL UPDATE

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1 Executive summary

Mid-band spectrum continues to be the focus of 5G deployment around the world. Over the past year, operators in several countries have launched commercial 5G services, many solely using mid-band spectrum. This has been made possible by the increasing availability of mid-band 5G spectrum in the last year, which is expected to continue during 2020 and beyond.

This paper references previous Analysys Mason papers on 5G[1] and assesses the latest 5G licensed mid-band spectrum plans. It specifically looks at licensed spectrum between 3GHz and 7GHz for 5G, contrasting plans in the US with those of other leading markets. The list of benchmark countries where we contrast availability of spectrum is as follows: Australia, Canada, China, France, Germany, Hong Kong, Italy, Japan, Qatar, South Korea, Spain, Sweden, UK, and the US.

Key finding: Compared to the 13 other markets, the US is far behind in terms of licensed mid-band spectrum currently available. Indeed, no licensed mid-band spectrum is currently available in the US, putting it in tied for last position.

Key finding: An average of 382MHz of licensed mid-band spectrum per benchmark country is expected to be assigned by the end of this year, while the US will have only 70MHz. This means other countries will have over five times more mid-band spectrum than the US by the end of 2020.

Key finding: Other countries are moving rapidly to make further mid-band spectrum available. The average amount of licensed mid-band spectrum expected to be assigned by the end of 2020 for five of the nations leading in mid-band spectrum release (Canada, China, Japan, South Korea, and the UK) is up 32 percent from the previous release of this report (December 2018). In addition, regulators in several other countries, such as Hong Kong, not included in our December 2018 report, have made mid-band spectrum available exceeding that of the US. From the end of 2020 to 2022, the average amount of mid-band for the five leading nations as above is projected to grow by a further 22 percent to over 660MHz.

Key finding: While the US is expected to have assigned 350MHz of licensed mid-band spectrum by 2022, it will still lag behind several other leading markets (including Canada, China, Hong Kong, Japan, South Korea and the UK), which have moved and/or are continuing to move aggressively in terms of mid-band spectrum assignment.

Key finding: Outside the US, every MNO – 19 out of 19 – that has launched 5G in these benchmark countries has used mid-band spectrum to do so.

Key finding: To remain a 5G leader, making more licensed mid-band spectrum available beyond the CBRS (3.55–3.65GHz range) and 3.7–3.98GHz bands remains an urgent goal for the US.

1 See https://www.ctia.org/news/u-s-tied-with-china-in-global-5g-race-new-report-finds

2 Update on 5G mid-band spectrum releases

2.1 Current and future mid-band spectrum assignments

Around the world, mid-band 5G spectrum plans progressed during 2019, with several countries launching commercial 5G services using mid-band spectrum and other countries at an advanced stage with their plans. The amount of licensed mid-band spectrum currently assigned and available for 5G deployment[2] in our benchmark countries, and the amount expected to be assigned or auctioned by the end of 2020, and by the end of 2022, is shown in Figure 2.1.

Figure 2.1: Licensed 5G mid-band spectrum assignments[3] [Source: Analysys Mason, 2020]

Country	Current assignment (MHz)	Additional assignment expected by end of 2020 (MHz)	Total assignment expected by end of 2020 (MHz)	Total assignment expected by end of 2022 (MHz)
Australia	225	-	225	300
Canada[4]	-	200	200	480
China	460	-	460	460
France	-	310	310	310
Germany	400	-	400	400
Hong Kong	380	-	380	460
Italy	326	-	326	326
Japan	800	200	1000	1000
Qatar	200	-	200	400
South Korea	280	-	280	600
Spain	360	-	360	360
Sweden	80	260	340	340
UK[5]	~670	120	~790	~790
US	-	70	70	350
Average	**380**	**193**	**382**	**470**

* Average only includes benchmark countries which have released spectrum

2 Whilst much of the available mid-band spectrum has been licensed to mobile carriers, some regulators are also looking at various ways to make 5G services available to end users, small businesses, industry and local areas, which includes the offering of local, private, or vertical 5G licenses using mid-band spectrum.

3 Spectrum for indoor use only (i.e. the 3.3–3.4GHz band in China and Hong Kong) is included. Spectrum licensed on a local/individual basis (i.e. 3.7–3.8GHz in Germany, 4.6–4.8GHz in Japan and 3.8–4.2GHz in the UK) is included. Spectrum that is only suitable/used for fixed wireless access (FWA) (e.g. the 3.41–3.46GHz range in France) is excluded. FWA refers to fixed wireless services using point-to-multi-point architectures.

4 ISED has proposed assigning spectrum in the 3.7–4.2GHz band in 2022. For the purposes of our chart/ tallies, we have assumed Canada will follow the US and assign the lower 280MHz of the band to mobile.

5 Spectrum in the 3.8–4.2GHz band in the UK is currently available for use on a local basis across the country (though certain exclusion zones apply).

2.2 Summary of mid-band spectrum per market

A summary of licensed mid-band spectrum assignments and release plans in each of our benchmark countries is shown in Figure 2.2 below.[6]

Figure 2.2: Licensed 5G mid-band spectrum assignments and release plans in benchmark countries [Source: Analysys Mason, 2020]

Country	Details of current and future licensed mid-band spectrum assignments	Licensed mid-band spectrum (MHz)
Australia	• Spectrum in the 3.425–3.4925GHz and 3.5425–3.575GHz ranges (a total of 100MHz across the two bands) has been licensed in specific areas of Australia. • A regional auction of the 3.575–3.7GHz range was completed in December 2018. • The ACMA has confirmed plans to reconfigure the 3.4–3.4575GHz range to make more spectrum available for wireless broadband. Additional spectrum is expected to be made available (in certain areas) by 2022 in the 3.4–3.425GHz and 3.4925–3.5425GHz ranges.	**Current:** 225MHz **EOY 2020:** 225MHz **EOY 2022:** 300MHz
Canada	• An auction of spectrum in the 3.45–3.65GHz range is expected in late 2020. • Proposals for the reconfiguration of the 3.65–3.7GHz band to accommodate 5G services, as well as auction of spectrum in the 3.7–4.2GHz band in 2022, have also been put forward for future consultation. For the purposes of our chart/tallies, we have assumed that Canada will follow the US and assign the lower 280MHz of the 3.7–4.2GHz band for mobile use.	**Current:** 0MHz **EOY 2020:** 200MHz **EOY 2022:** 480MHz
China	• In June 2019, MIIT awarded commercial 5G licenses to the country's three MNOs in the 3.4–3.6GHz and 4.8–4.9GHz ranges, as well as to China Broadcasting Network (CBN) in the 4.9–4.96GHz band. • In February 2020, MIIT announced that the 3.3–3.4GHz spectrum range had been licensed to China Telecom, China Unicom and CBN for 5G indoor use.	**Current:** 460MHz **EOY 2020:** 460MHz **EOY 2022:** 460MHz
France	• In December 2017, the French regulator ARCEP made (parts of) the 3.41–3.46GHz range available for FWA use in certain areas until 2026. • In November 2019, ARCEP adopted a decision on rules for the auction of the 3.49–3.8GHz range (for nationwide use). The auction is scheduled to take place in the first half of 2020.	**Current:** 0MHz **EOY 2020:** 310MHz **EOY 2022:** 310MHz

6 In most cases, spectrum becomes available for use immediately (or shortly) after it is assigned. Where there is no data available to the contrary, we have assumed that that is the case. In some instances (e.g. France, Germany, Sweden and the UK), spectrum will become available immediately (or shortly) after assignment in most locations, however there will be a delay before there is complete nationwide availability due to the migration of incumbent licensees in specific locations (see Annex A for details). For the purposes of the chart/tallies, we count the spectrum as all being immediately available.

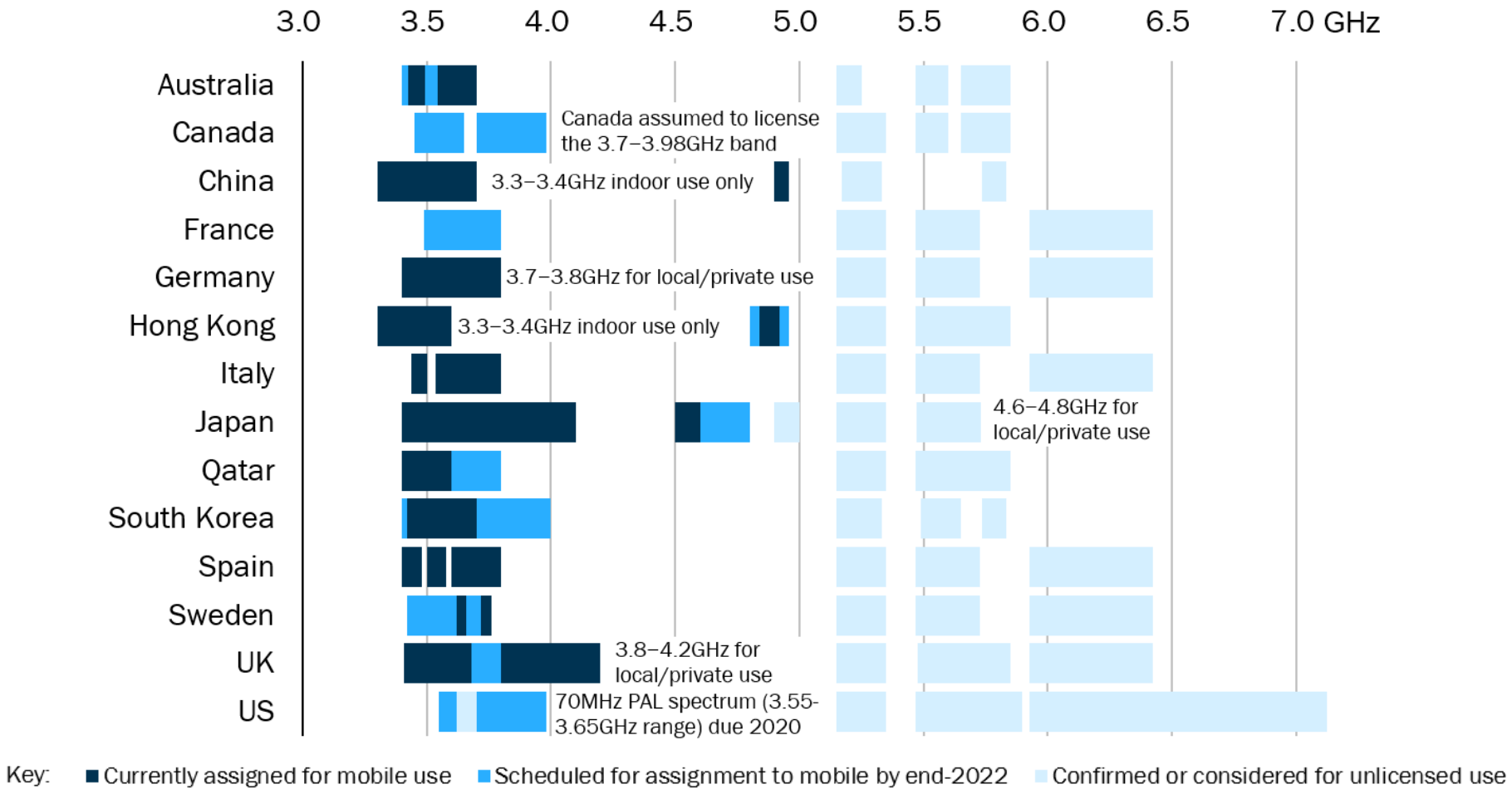
In the 3.7–3.98GHz band in the US, there is an important distinction between assignment and availability: the full range is scheduled for auction in December 2020, but the lower 100MHz is likely to become available in September 2021 and the remaining 180MHz in September 2023. For purposes of the chart/tallies, we have counted all 280MHz as available by the end of 2022.

Country	Details of current and future licensed mid-band spectrum assignments	Licensed mid-band spectrum (MHz)
Germany	• An auction of the 3.4–3.7GHz spectrum range (for nationwide use) was completed in June 2019. • In November 2019, the regulator BNetzA opened applications for local licenses in the 3.7–3.8GHz range. Blocks of 10MHz each are available for private use to provide "innovative 5G solutions".	**Current:** 400MHz **EOY 2020:** 400MHz **EOY 2022:** 400MHz
Hong Kong	• An auction of the 3.4–3.6GHz and 4.84–4.92GHz ranges (for nationwide use) was completed in October 2019. • An auction of the 3.3–3.4GHz range (for indoor use) was completed in November 2019. • OFCA intends to issue a consultation during 2020 on plans to award 80MHz in the 4.8–4.84GHz and 4.92–4.96GHz spectrum ranges for the provision of mobile services during 2021.	**Current:** 380MHz **EOY 2020:** 380MHz **EOY 2022:** 460MHz
Italy	• 200MHz of spectrum in the 3.6–3.8GHz range (for nationwide use) and 126MHz of spectrum in the 3.4–3.6GHz band is currently available.	**Current:** 326MHz **EOY 2020:** 326MHz **EOY 2022:** 326MHz
Japan	• The 3.4–3.48GHz range was assigned (for nationwide use) in April 2018. • The 3.48–3.6GHz range was assigned (for nationwide use) in December 2018. • The 3.6–4.1GHz and 4.5–4.6GHz ranges were assigned (for nationwide use) in April 2019. • The 4.6–4.8GHz range is expected to be awarded in the future for private 5G use. Configuration is likely to be finalized in the second half of 2020.	**Current:** 800MHz **EOY 2020:** 1000MHz **EOY 2022:** 1000MHz
Qatar	• A total of 100MHz per operator has been assigned to each of the two MNOs in the 3.4–3.6GHz range. • A document released by CRA in February 2018 indicates that spectrum in the 3.6–3.8GHz range will be assigned for 5G use in the future. CRA is expected to reach a decision on this release by Q3 2021.	**Current:** 200MHz **EOY 2020:** 200MHz **EOY 2022:** 400MHz
South Korea	• South Korea auctioned the 3.42–3.70GHz range on a national basis in June 2018 for 5G use. • In November 2019, MSIT launched its "5G+ spectrum plan" which aims to "secure the world's largest 5G spectrum supply" by releasing an additional 2640MHz of 5G spectrum by 2026. This includes assigning 320MHz in the 3.4–3.42GHz and 3.7–4GHZ ranges by 2021, thus making available 600MHz of contiguous spectrum in the mid-band.	**Current:** 280MHz **EOY 2020:** 280MHz **EOY 2022:** 600MHz
Spain	• In June and July 2018, MNO MásMóvil privately acquired two 2×20MHz (80MHz in total) national licenses in the 3.4–3.6GHz band; two of Spain's other MNOs (Orange and Telefónica) already own 2×20MHz national licenses in this band. • An auction of 200MHz of spectrum in the 3.6–3.8GHz range (for nationwide use) was completed in July 2018.	**Current:** 360MHz **EOY 2020:** 360MHz **EOY 2022:** 360MHz

Country	Details of current and future licensed mid-band spectrum assignments	Licensed mid-band spectrum (MHz)
Sweden	• 2×40MHz in the 3.62–3.66/3.72–3.76GHz ranges has been assigned to MNOs on a national basis (expiring in December 2022). • Some (technology neutral) regional licenses have also been assigned in the remainder of the 3.4–3.8GHz band. • PTS is planning to award the 3.42–3.72GHz range to mobile (alongside the 2.3–2.38GHz range) in October 2020. • The 3.72–3.8GHz band is planned for local use (e.g. for private 5G networks) and is expected to be released from 2023 onward.	**Current:** 80MHz **EOY 2020:** 340MHz **EOY 2022:** 340MHz
UK	• The UK completed the auction of 150MHz of 3.4–3.6GHz spectrum in June 2018. • In July 2019, Ofcom announced new spectrum-sharing arrangements in the 3.8–4.2GHz band. Local licenses will be assigned by Ofcom on a FCFS basis. • MNO Three also holds various mid-band spectrum licenses on a national basis through its acquisition of UK Broadband. • The UK anticipates awarding 120MHz of spectrum in the 3.68–3.8GHz band in H2 2020.	**Current:** ~670MHz **EOY 2020:** ~790MHz **EOY 2022:** ~790MHz
US	• 70MHz in the CBRS band is expected to be auctioned in mid-2020 on a wide-area (county) basis. • In February 2020, the FCC announced that an auction of 280MHz in the 3.7-3.98GHz range would begin in December 2020; the lower 100MHz is likely to be available for use by September 2021 and the remaining 180MHz by September 2023. • In December 2019, the FCC announced that it was also exploring use cases for the 3.1–3.55GHz in terms of 5G services but no timetable is available for commercial release.	**Current:** 0MHz **EOY 2020:** 70MHz **EOY 2022:** 350MHz

The mid-band spectrum ranges for each of our benchmark countries are shown in Figure 2.3. The figure highlights the amount of spectrum currently licensed for mobile use and the amount scheduled to be licensed by the end of 2022. The amount of spectrum currently available on an unlicensed basis, and spectrum confirmed or considered for unlicensed use, is also shown.

Figure 2.3: 5G mid-band spectrum in benchmark countries[7] [Source: Analysys Mason, 2020]



7 Different conditions and technical criteria may apply to each of the unlicensed spectrum frequencies.

Annex A Country profiles

The following section provides details of the expected release of mid-band spectrum for 5G in each of our benchmark countries. For each country we provide:

- an overview of the mid-band 5G spectrum situation
- any relevant operator developments relating to commercial launch of 5G services
- information regarding the expected date for mid-band spectrum release.

A.1 Australia

Current assignment: Spectrum in the 3.425–3.4925GHz and 3.5425–3.575GHz ranges (a total of 100MHz across the two bands) has been licensed in specific areas of Australia. A regional auction of the 3.575–3.7GHz range was completed in December 2018.

Future assignment: The ACMA has announced plans to reconfigure the 3.4–3.575GHz band in order to make more spectrum available for wireless broadband. The 3.4–3.425GHz and 3.4925–3.5425GHz ranges are planned to be made available (in certain areas) in 2022.

Overview of mid-band spectrum

MNOs Telstra and Optus (and state-owned wholesale broadband provider NBN Co) have been assigned technology neutral spectrum licenses in the 3.425–3.4925GHz and 3.5425–3.575GHz ranges on a regional basis. The remainder of the 3.4–3.575GHz band is currently available to NBN Co (in metro and certain other areas) via PTS[8] licenses; NBN Co. is currently using this spectrum to provide FWA services in certain locations.[9]

Following consultation,[10] in November 2019 the ACMA announced plans to reconfigure the 3.4–3.575GHz range in order to defragment the band and make more spectrum available for wireless broadband.[11] The 3.4–3.425GHz and 3.4925–3.5425GHz ranges are planned to be made available (in certain areas) by 2022.

8 A public telecommunications service (PTS) license allows the licensee to operator one or more stations to provide a public mobile telecommunications service. PTS licenses are a type of apparatus license, which allow the operation of specified transmitters or receivers. NBN Co's PTS licenses are for public mobile telecommunications Class B services (PMTS Class B), meaning they are wide area licenses that can be used to deploy similar services to spectrum licenses. See https://www.acma.gov.au/apparatus-licences

9 Details of current licensees in the 3.4–3.575GHz band are provided in Annex C of the April 2019 options paper.

10 See https://www.acma.gov.au/consultations/2019-08/optimising-3400-3575-mhz-band-consultation-122019

11 See https://www.acma.gov.au/sites/default/files/2019-11/IFC-12-2019-Optimising-arrangements-3400-3575-MHz-band_Planning-decisions-and-preliminary-views.docx

The plans involve: (i) consolidating NBN Co's PTS licenses and converting them to spectrum licenses, (ii) making NBN Co's PTS licensed spectrum available to other operators where it is currently unused in urban

In December 2018, the ACMA completed a regional auction[12] of spectrum in the 3.575–3.7GHz band; Telstra, Optus, and Mobile JV (TPG and VHA's joint venture) each won spectrum.

The ACMA launched a consultation on reconfiguration options for the 3.7–4.2GHz band in September 2019.[13] A discussion paper on the outcome of the consultation is scheduled for Q1 2020.

In Australia, the 5.15–5.35GHz (indoor only), 5.47–5.6GHz and 5.65–5.85GHz bands are available for unlicensed use.[14] No further spectrum is expected to be released in the 6GHz band prior to 2022, however the ACMA has stated its intention to monitor global developments.[15]

Operator developments

Two of the three Australian MNOs, Telstra[16] and Optus,[17] have launched commercial 5G mobile services using mid-band spectrum.

VHA[18] is planning to launch its commercial 5G service with 3.6GHz band spectrum in the first half of 2020.

areas, and (iii) designating additional spectrum for the issue of spectrum licenses (allocating 25MHz of spectrum in major regional centers and 42.5MHz in defined regional areas). See decision paper for details.

12 For full auction details, see https://www.acma.gov.au/auction-summary-36-ghz-band-2018

13 See https://www.acma.gov.au/consultations/2019-09/planning-3700-4200-mhz-band-consultation-272019

14 See https://www.legislation.gov.au/Series/F2015L01438

15 See https://www.acma.gov.au/sites/default/files/2019-09/Five-year%20spectrum%20outlook%202019-23.pdf

16 Commercial FWA and mobile 5G services became available from Telstra (using its spectrum assignment in the 3.575–3.655GHz range) after the launch of its first 5G devices in May 2019. See https://www.telstra.com.au/aboutus/media/media-releases/The_5G_smartphone_future_begins_Telstra_stores and https://www.telstra.com.au/aboutus/media/media-releases/Telstra_launches_Australias_first_5G_mobile_device

17 Optus launched its FWA and mobile 5G offering in November 2019. Services are provided over regional blocks of 3.4GHz and national 3.665–3.7GHz spectrum, and Optus has announced plans to strengthen its 5G network using regionally available 2.3GHz spectrum in 2020. See https://www.optus.com.au/about/media-centre/media-releases/2019/11/optus-differentiates-with-5g-delivering-both-mobile-on-the-go-and-in-home-with-new-4k-ultra-hd-video-streaming-partnerships and https://www.zdnet.com/article/optus-completes-5g-data-call-using-2300mhz-spectrum/

18 VHA has announced plans to partner with Nokia and to deploy and launch commercial 5G services in the first half of 2020 using the 3.6GHz spectrum license it acquired through Mobile JV. See https://www.nokia.com/about-us/news/releases/2019/12/30/vodafone-partners-with-nokia-to-deliver-5g/ and https://www.vodafone.com.au/support/network/5g. See also https://www.vodafone.com.au/media/vodafone-lights-up-first-5g-sites-in-parramatta

Expected date for mid-band spectrum release

Figure A.1: Details of 5G mid-band spectrum assignment in Australia [Source: ACMA, 2020]

Category	Details
Spectrum to be released	3.4–3.425GHz and 3.4925–3.5425GHz ranges (75MHz) scheduled for release 3.7–4.2GHz (500MHz) scheduled for consultation on reconfiguration options
Expected date	3.4–3.425GHz and 3.4925–3.5425GHz ranges: planned to be made available (in certain areas) by 2022 3.7–4.2GHz: reconfiguration consultation scheduled for Q1 2020

A.2 Canada

Current assignment: No mid-band spectrum is currently available for commercial mobile services.

Future assignment: An auction of spectrum in the 3.45–3.65GHz range is expected in late 2020. The regional licensing arrangements have not yet been specified, but we note that the 3.45–3.65GHz spectrum band is designated for flexible use in Tier 4 (localized service) areas. Proposals for the reconfiguration of the 3.65–3.7GHz band to accommodate 5G services, as well as auction of spectrum in the 3.7–4.2GHz band in 2022, have also been put forward.

Overview of mid-band spectrum

On June 6, 2018, ISED published[19] its "Spectrum Outlook 2018 to 2022" report. This document categorizes each band under discussion into one of three priority groups:

- Bands identified as "Priority 1".[20] These are planned for release between 2018 and 2022.
- Bands identified as "Priority 2".[21] These could potentially be released between 2018 and 2022, subject to international developments such as WRC-19 and equipment availability.
- Bands identified as "Priority 3". These will be regularly monitored by ISED during the period 2018 to 2022. Based on currently available information, there is uncertainty regarding the international developments or potential equipment available for these bands.

In 2014, ISED decided to adopt a flexible use policy across the 3.475–3.65GHz band and implement a reallocation to allow mobile services in addition to existing fixed services.[22]

In 2018, ISED released a consultation[23] on the 3.4–3.65GHz and 3.65–4.2GHz bands. ISED proposed to extend the allocation of flexible use spectrum in the 3.475–3.65GHz band by 25MHz (i.e. to 3.45–3.65GHz). ISED's "Spectrum Outlook 2018 to 2022" classified the 3.45–3.65GHz range as Priority 1 and scheduled an auction for late 2020; auction rules were published in March 2020.[24] The 3.65–4.2GHz range is considered to be Priority 2.

19 See http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf11403.html

20 These are generally bands that have established international standards, and for which equipment is available or is expected to be available. In some cases, work to make these bands available in Canada is already underway.

21 For bands identified as Priority 2, ISED expects to begin work (e.g. policy or technical standard development, review of existing and potential uses and/or international co-ordination) between 2018 and 2022.

22 See https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf10914.html. Note: in 2004, 10-year licenses were auctioned in the 3.475–3.65GHz band on a regional basis for FWA use. In 2014, ISED decided to allow for annual renewal of these licenses upon expiration.

23 See https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf11401.html

24 Spectrum will be auctioned in Tier 4 service areas (of which there are 172 in total). ISED will reserve 50MHz (in areas where enough spectrum is available) for smaller and regional players. Existing licensees are eligible to apply for licenses for a predetermined amount of spectrum, based on their existing holdings in a specific area. Since existing users are retaining some spectrum, the amount available for auction varies

In June 2019, ISED launched a consultation[25] on auction rules for the 3.45–3.65GHz band, scheduled for 2020. The spectrum is proposed to be licensed on a flexible use basis, defined as a "combination of FWA, mobile and backhaul components to be deployed as part of 5G networks" in ISED's "Spectrum Outlook 2018 to 2022" report.[26]

In June 2019, ISED also proposed the auction of additional 5G spectrum in the 3.7–4.2GHz band in 2022, and announced plans for further study of the 3.65–3.7GHz band via a future consultation.[27] For the purposes of our chart/tallies, we have assumed that Canada will follow the US and assign the lower 280MHz of the 3.7–4.2GHz band to mobile.

In Canada, the 5.15–5.35GHz,[28] 5.47–5.6GHz, and 5.65–5.85GHz bands are available for unlicensed use. ISED's "Spectrum Outlook 2018 to 2022" notes that there is interest in considering the 6GHz band for commercial mobile and/or license exempt use and considers the band to be Priority 3. ISED will monitor the global situation and revisit the priority level should significant international advancements develop.[29]

Operator developments

No MNO in Canada has yet launched commercial 5G mobile services using mid-band spectrum in the 3–7GHz band.

between 30MHz and 140MHz across the Tier 4 service areas. See https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf11584.html and https://www.canada.ca/en/innovation-science-economic-development/news/2020/03/3500-mhz-band-spectrum-auction.html

25 See https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf11439.html

26 We understand that spectrum will be available for use from the date that licenses are first issued following the auction procedure

27 See http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf11437.html

28 The 5.15–5.35GHz range requires a license for outdoor and high EIRP (>200mW) use. See https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf10971.html#s6.2.1

29 See Section 8.2.6. See https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf11403.html

However, all three of the country's nationwide MNOs, Bell,[30] Rogers[31] and Telus,[32] as well as Videotron,[33] have announced plans to launch 5G using the 3.5GHz band in the future (after the spectrum has been auctioned).[34]

Expected date for mid-band spectrum release

Figure A.2: Details of 5G mid-band spectrum assignment in Canada [Source: ISED, 2020]

Category	Details
Spectrum to be released	3.45–3.65GHz (200MHz) scheduled for auction 3.65–3.7GHz (50MHz) proposed for reconfiguration consultation in the future 3.7–4.2GHz (likely 280MHz within the band) proposed for auction
Expected date	3.45–3.65GHz: scheduled for auction in 2020 3.7–4.2GHz: proposed for auction in 2022

30 In February 2020, Bell stated that it "is ready to deliver initial 5G service in urban centres across Canada as next-generation smartphones come to market in 2020, and will continue to enhance 5G access speeds, capacity and coverage as additional 5G wireless spectrum, including in the 3.5GHz band, becomes available this year through the federal government's spectrum auction process". See https://www.bce.ca/news-and-media/releases/show/bce-reports-2019-q4-and-full-year-results-announces-2020-financial-targets-1

31 In January 2020, Rogers announced initial deployment of Canada's first 5G network in downtown areas of Vancouver, Toronto, Ottawa, and Montreal, so that it will be ready when 5G devices become available later in 2020. Rogers will initially use 2.5GHz and will expand to use 600MHz later in 2020. Rogers also announced its intention to deploy 5G over 3.5GHz in the future.
See https://about.rogers.com/news-ideas/rogers-starts-rollout-of-canadas-first-5g-network-and-joins-global-5g-forum/

32 In February 2020, Telus stated that commercial 5G services would be launched later in 2020. 3.5GHz spectrum is not expected to be widely rolled out until 2021 (after it is made available in Q4 2020); initial services will therefore use other spectrum. See https://business.financialpost.com/telecom/telus-to-launch-5g-network-with-huawei-by-the-end-of-2020

33 Videotron plans to launch 5G commercial services using the 3.5GHz and 28GHz bands toward the end of 2020. See https://news.samsung.com/ca/samsung-selected-as-4g-lte-a-5g-network-solution-provider-by-videotron-in-canada

34 In February 2020, each of the nationwide MNOs announced that 5G smartphones would be available from March 2020, suggesting that initial 5G mobile services may be available from that date. See, for example, https://www.newswire.ca/news-releases/bell-bringing-the-first-5g-smartphones-the-samsung-galaxy-s20-5g-series-to-canada-801389619.html. However, services will be limited until the 3.5GHz band is auctioned.

A.3 China

Current assignment: In June 2019, MIIT awarded commercial 5G licenses to the three MNOs in the 3.4–3.6GHz and 4.8–4.9GHz ranges, as well as to China Broadcasting Network (CBN) in the 4.9–4.96GHz band. In February 2020, the 3.3–3.4GHz band was licensed for indoor 5G use.

Future assignment: None confirmed at this time.[35]

Overview of mid-band spectrum

In June 2017, MIIT released a consultation[36] on using spectrum in the 3.3–3.6GHz and 4.8–5GHz ranges for 5G technologies, with the 3.3–3.4GHz range limited to indoor use. These ranges were confirmed in a subsequent announcement[37] in November 2017, with MIIT adding that it would not approve any further fixed or satellite licenses in these bands.

In June 2019, MIIT awarded commercial 5G licenses[38] to each of the incumbent MNOs. China Mobile was assigned a license in the 4.8–4.9GHz range,[39] China Telecom in the 3.4–3.5GHz range, and China Unicom in the 3.5–3.6GHz range. China Broadcasting Network (CBN) was also awarded a 5G commercial license; reports indicate that this was in the 4.9–4.96GHz range.[40] In January 2020, CBN received a 5G test license from MIIT in the 4.9GHz band; MIIT did not specify the exact spectrum range of the license.[41]

In February 2020, MIIT announced that it has assigned the 3.3–3.4GHz band to China Telecom, China Unicom and CBN for 5G indoor use.[42]

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35 We note that MIIT has previously referred to the 4.4–4.5GHz range for 5G. See https://www.itu.int/en/ITU-D/Regional-Presence/AsiaPacific/Documents/Events/2017/Sep-SECB/Presentations/D1-2-Kan%20Runtian-Radio%20Spectrum%20Management%20Strategies%20in%20China.pdf

36 See https://www.fiercewireless.com/wireless/china-issues-plan-to-use-3300-3600-mhz-4800-5000-mhz-for-5g

37 See http://www.miit.gov.cn/n1146295/n1652858/n1652930/n3757020/c5907905/content.html, http://www.miit.gov.cn/n1146290/n4388791/c5906943/content.html, http://www.caict.ac.cn/xwdt/hyxw/201711/t20171115_2214806.htm and http://www.srrc.org.cn/en/news3434.aspx

38 See https://static1.squarespace.com/static/5bf2b77d75f9eefcd937cb5c/t/5d1a20eb11a9570001f95d65/1561993455970/5.+Julin+LIU.pdf and http://www.miit.gov.cn/n1146290/n1146402/n7039597/c7093441/content.html

39 China Mobile was also awarded a 5G commercial license in the 2.515–2.675GHz range.

40 The exact range assigned to CBN is unclear. Several sources report that the 4.9–4.96GHz range has been assigned. For example, see http://m.c114.com.cn/w1991-1104749.html and http://www.biyige.com/article/59622.html. However, other sources report different amounts, e.g. https://www.ibc.org/publish/china-unveils-new-5g-broadcast-trials/4268.article

41 See http://www.miit.gov.cn/n1146290/n1146402/n1146440/c7597192/content.html. As noted above, the exact range assigned to CBN is unclear. For our tallies, we have assumed that the 4.9–4.96GHz range has been assigned to CBN.

42 See http://www.miit.gov.cn/n1146290/n1146402/c7671201/content.html

MIIT has made the 5.17–5.33GHz and 5.735–5.835GHz bands available for unlicensed use.[43]

Operator developments

All three of the Chinese MNOs, China Mobile, China Telecom and China Unicom,[44] have launched commercial 5G mobile services using mid-band spectrum.

CBN also plans to use mid-band spectrum for its 5G deployment in 2020.[45]

43 See https://wifiamateur.blogspot.com/2013/04/china-opened-more-channels-in-5-ghz.html

44 All three MNOs officially launched commercial 5G mobile services in October 2019. See https://www.cnbc.com/2019/10/31/chinas-state-telecoms-to-launch-5g-services-on-friday.html

45 In November 2019, CBN announced plans to launch commercial 5G services in 2020 using the 700MHz and 4.9GHz bands. We understand that the initial launch will use the 700MHz band to deliver HD video content. See https://www.lightreading.com/asia-pacific/chinas-cbn-starts-5g-trials-amid-doubts/d/d-id/754533, http://www.c114.com.cn/swrh/1991/a1109380.html and http://www.c114.com.cn/swrh/1991/a1109383.html

A.4 France

Current assignment: In December 2017, ARCEP made (parts of) the 3.41–3.46GHz range available for FWA use in certain areas until 2026.

Future assignment: In November 2019, ARCEP adopted a decision on rules for the auction of the 3.49–3.8GHz range (for nationwide use). The auction is scheduled to take place in the first half of 2020.[46]

Overview of mid-band spectrum

A 40MHz block of 3.42–3.46GHz[47] spectrum is currently available for FWA in specific geographical areas[48,49] (with an additional 10MHz at 3.41–3.42GHz in certain areas, depending on coexistence constraints). This spectrum is technology neutral, though it is earmarked for "very high-speed" ('THD') radio networks. Applications for THD spectrum remain open until September 2020 and licenses are expected to expire in 2026.[50]

In November 2019, ARCEP submitted to the government its decision on rules and conditions for the auction of 5G spectrum in the 3.49–3.8GHz range (for nationwide use).[51] The government approved ARCEP's conditions for assignment in December 2019, thus launching a formal procedure for the award of 310MHz of contiguous spectrum in the 3.49–3.8GHz range.[52] The assignment process is scheduled to conclude within the first half of 2020.[53]

46 See https://www.arcep.fr/actualites/les-communiques-de-presse/detail/n/5g-7.html and https://en.arcep.fr/news/press-releases/p/n/5g-10.html

47 The entire 3420–3460MHz range is not available in all departments. See https://www.arcep.fr/index.php?id=13756

48 That is, areas not covered by FTTH deployments (the purpose of assigning the spectrum for FWA is to boost high-speed connectivity in France). Operators can apply for a license within a particular department, but coverage is only permitted in areas not covered by FTTH. For example, in the Seine-et-Marne department, operator Sem@for77 is licensed to cover 142 communes representing 33% of the total area of the department.

See https://www.arcep.fr/fileadmin/reprise/dossiers/thd-radio/FichesSynthese/Fiche_77__Semafor77.pdf

49 A consultation on FWA spectrum was published on July 13, 2017, and a document outlining the assignment approach on December 11, 2017. As of March 2018, players are able to request regional FWA licenses from the regulator. See:
https://www.arcep.fr/uploads/tx_gspublication/consult-attribution-THD_radio-juil2017.pdf
https://www.arcep.fr/uploads/tx_gspublication/modalites_attribution_THD_radio-dec2017.pdf
https://www.arcep.fr/?id=7108

50 See https://www.arcep.fr/actualites/les-communiques-de-presse/detail/n/frequences-4.html and https://www.arcep.fr/thdradio.html. Note: the 3.4–3.49GHz range is expected to be subject to a subsequent assignment procedure by 2026. See https://www.arcep.fr/uploads/tx_gsavis/19-1386.pdf

51 See https://en.arcep.fr/news/press-releases/p/n/5g-7.html

52 See https://en.arcep.fr/news/press-releases/p/n/5g-10.html

53 Spectrum will be available either immediately, from July 2020 or from January 2021, depending on the area.

In accordance with the European standard, the 5.15–5.35GHz (indoor only) and 5.47–5.725GHz bands are available for unlicensed use in EU Member States.[54] Furthermore, EU countries are harmonizing the lower part of the 6GHz band (i.e. 5.925–6.425GHz) for unlicensed use.[55]

Operator developments

No MNO in France has yet launched commercial 5G mobile services using mid-band spectrum.

In January 2018, ARCEP opened applications for 5G pilot sites in the 3.4–3.8GHz range.[56] By July 2019, the Agence Nationale des Fréquences (ANFR) had authorized a total 273 5G pilot sites over 3.4–3.8GHz spectrum.[57] All four of the French MNOs,[58] Orange, Bouygues, SFR, and Free, have set up 5G pilot sites in cities across France, making use of the 3.4–3.8GHz set aside by ARCEP for test licenses.

Expected date for mid-band spectrum release

Figure A.3: Details of 5G mid-band spectrum assignment in France [Source: ARCEP, 2019, 2020]

Category	Details
Spectrum to be released	3.49–3.8GHz (310MHz) scheduled for auction
Expected date	H1 2020

54 See https://www.etsi.org/deliver/etsi_en/301800_301899/301893/02.01.01_60/en_301893v020101p.pdf and https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32005D0513

55 Technical conditions are not expected to be finalized before the end of 2020. Assignment in individual Member States likely to take place in 2021 and beyond. See https://www.ecodocdb.dk/document/10170 and http://apps.cept.org/eccnews/aug-2019/europe_prepares_to_harmonise_the_6_ghz_spectrum_band_for_radio_local_area_networks.html

56 See https://www.arcep.fr/actualites/les-communiques-de-presse/detail/n/frequences-5g.html

57 See https://www.anfr.fr/gestion-des-frequences-sites/lobservatoire/actualites/actualite/actualites/observatoire-anfr-plus-de-47-200-sites-4g-autorises-par-lanfr-en-france-au-1er-aout-2019/
Examples of pilot sites and 5G experiments in France can be found here https://www.arcep.fr/cartes-et-donnees/nos-publications-chiffrees/experimentations-5g-en-france/tableau-deploiements-5g.html

58 As of November 2019, Orange was leading in the number 5G pilots authorised by ANFR. Since August 2018 Orange had requested 311 authorisations compared to 62 for Bouygues, 25 for SFR and 8 for Free. SFR has announced plans to launch 5G services in the first half of 2020. See https://blog.ariase.com/mobile/dossiers/5g-sfr

A.5 Germany

Current assignment: An auction of the 3.4–3.7GHz spectrum range (for nationwide use) was completed in June 2019.[59] In November 2019, BNetzA opened applications for local licenses in the 3.7–3.8GHz range.[60]

Future assignment: None confirmed at this time.

Overview of mid-band spectrum

In June 2019, BNetzA completed an auction of 3.4–3.7GHz spectrum (for nationwide use).[61]

BNetzA has also reserved spectrum in the 3.7–3.8GHz band for local networks.[62] In March 2019, BNetzA published[63] a framework for local 5G applications in this band; applications were opened in November 2019. The private spectrum licenses[64] are to be awarded on a local basis and used for "innovative 5G local solutions" in the industrial or small business sectors.

In accordance with the European standard, the 5.15–5.35GHz (indoor only) and 5.47–5.725GHz bands are available for unlicensed use in EU Member States.[65] Furthermore, EU countries are harmonizing the lower part of the 6GHz band (i.e. 5.925–6.425GHz) for unlicensed use.[66]

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59 See https://www.bundesnetzagentur.de/SharedDocs/Pressemitteilungen/EN/2019/20190612_spectrumauctionends.html

60 See https://www.bundesnetzagentur.de/SharedDocs/Pressemitteilungen/DE/2019/20191121_lokaleFreq.html?nn=265778

61 For an index of relevant documentation, see https://www.bundesnetzagentur.de/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Breitband/MobilesBreitband/Frequenzauktion/2019/Auktion2019.html;jsessionid=957837A1C89BD4480A90F77298AC067E?nn=268128. Spectrum in the 2.1GHz band was also assigned in the same auction. Note: due to incumbent FWA licenses, we understand that the 3.4–3.7GHz spectrum will not become available nationwide until the end of 2022; however, it will be available in certain locations prior to this date.

62 For an index of relevant documentation, see https://www.bundesnetzagentur.de/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Frequenzen/OeffentlicheNetze/LokaleNetze/lokalenetze-node.html

63 See https://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Frequenzen/OffentlicheNetze/RegionaleNetze/Entwurf%20Antragsverfahren%203,7%20-%203,8%20GHz.pdf?__blob=publicationFile&v=2

64 For examples of applicants, see https://enterpriseiotinsights.com/20191202/channels/news/siemens-applies-for-private-5g-spectrum-licences

65 See https://www.etsi.org/deliver/etsi_en/301800_301899/301893/02.01.01_60/en_301893v020101p.pdf and https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32005D0513

66 Technical conditions are not expected to be finalized before the end of 2020. Assignment in individual Member States likely to take place in 2021 and beyond. See https://www.ecodocdb.dk/document/10170 and http://apps.cept.org/eccnews/aug-2019/europe_prepares_to_harmonise_the_6_ghz_spectrum_band_for_radio_local_area_networks.html

Operator developments

Two of the four German MNOs, DT[67] and Vodafone,[68] have launched commercial 5G mobile services using mid-band spectrum.

The third MNO, Telefónica,[69] is planning to roll out 5G services in 2020; we understand that initial deployment will make use of its mid-band spectrum.

Expected date for mid-band spectrum release

Figure A.4: Details of 5G mid-band spectrum assignment in Germany [Source: BNetzA, 2020]

Category	Details
Spectrum to be released	3.7–3.8GHz (100MHz) for private licenses on an individual basis for local use
Expected date	It is unclear when the 3.7–3.8GHz band will become available; as of November 2019, businesses can apply for use of the spectrum

67 DT announced the initial deployment of its 5G network in September 2019. DT holds spectrum in the 3.61–3.7GHz range. See https://www.telekom.com/en/media/media-information/archive/deutsche-telekom-5g-goes-live-in-five-cities-580574

68 Vodafone launched commercial 5G services in 20 cities in June 2019. Vodafone holds spectrum in the 3.4–3.49GHz range. See https://www.reuters.com/article/us-germany-telecoms-vodafone-group/vodafone-launches-5g-in-germany-challenges-d-telekom-on-price-idUSKCN1UB1IY

69 Telefónica holds spectrum in the 3.54–3.61GHz range. See https://www.sdxcentral.com/articles/news/telefonica-germany-and-nokia-enter-5g-testing-stage-in-berlin/2018/12/

A.6 Hong Kong

Current assignment: An auction of the 3.4–3.6GHz[70] and 4.84–4.92GHz[71] ranges (for nationwide use) was completed in October 2019. An auction of the 3.3–3.4GHz range (for indoor use) was completed in November 2019.[72]

Future assignment: OFCA intends to issue a consultation during 2020 on plans to award 80MHz in the 4.8–4.84GHz and 4.92–4.96GHz spectrum ranges for the provision of mobile services during 2021.

Overview of mid-band spectrum

On December 13, 2018, the SCED and OFCA issued a final decision[73] on the assignment of 380MHz of spectrum in the 3.3–3.4GHz (for indoor use), 3.4–3.6GHz, and 4.84–4.92GHz bands for the provision of public mobile services.

In July 2019, OFCA opened applications for licenses in these three bands.[74] The 3.4–3.6GHz band was auctioned in October 2019. The 4.84–4.92GHz and 3.3–3.4GHz bands were awarded in late October and November 2019, respectively.

In January 2020, OFCA published a spectrum release plan for Hong Kong over the period 2020 to 2022.[75] OFCA intends to issue a consultation during 2020 on plans to award 80MHz in the 4.8–4.84GHz and 4.92–4.96GHz spectrum ranges for the provision of mobile services during 2021. Combined with the current 4.9GHz assignment, this spectrum release will make available 160MHz of contiguous spectrum for mobile services in the 4.9GHz band.

In Hong Kong, the 5.15–5.35GHz (indoor only) and 5.47–5.85GHz bands are available for unlicensed use.[76]

Operator developments

No MNO in Hong Kong has yet launched commercial 5G mobile services using mid-band spectrum.

70 See https://www.ofca.gov.hk/en/industry_focus/radio_spectrum/auctions/3_5_ghz_band_licensing/index.html

71 See https://www.ofca.gov.hk/en/industry_focus/radio_spectrum/auctions/4_9_ghz_band_licensing/index.html

72 See https://www.ofca.gov.hk/en/industry_focus/radio_spectrum/auctions/index.html

73 See https://www.coms-auth.hk/en/media_focus/press_releases/index_id_1824.html

74 See https://www.info.gov.hk/gia/general/201907/19/P2019071900551.htm

75 See https://www.coms-auth.hk/filemanager/en/content_613/spectrum_plan2020_en.pdf

76 See https://www.coms-auth.hk/filemanager/en/content_711/cp20180201.pdf

Three has announced plans to launch commercial 5G mobile services in April 2020 – the start date of its 3.56–3.6GHz license.[77] HKT has announced plans to deploy 5G using mid-band spectrum in the second half of 2020.[78] China Mobile HK[79] and SmarTone[80] have conducted 5G trials using mid-band spectrum.

Expected date for mid-band spectrum release

Figure A.5: Details of 5G mid-band spectrum assignment in Hong Kong [Source: OFCA, 2020]

Category	Details
Spectrum to be released	4.8–4.84GHz and 4.92–4.96GHz (80MHz)
Expected date	OFCA intends to issue a consultation during 2020 for the provision of mobile services during 2021

77 See https://www.thestandard.com.hk/breaking-news/section/2/143131/Hutch-Tel-readies-April-5G-launch

78 HKT, one of two operators with 4.9GHz spectrum, said that the 4.9GHz band will help to improve the speed and capacity of its 5G delivery, as well as enhance coverage in the densely populated areas of Hong Kong south and New Territories East where 3.5GHz frequency may encounter interference from satellites. See https://www.hkt.com/About%20HKT/Press%20information/Press%20Information%20Detail?guid=ab93f95a4b5fd610VgnVCM1000006a8ba8c0____&language=en_US and https://www.hkt.com/About%20HKT/Press%20information/Press%20Information%20Detail?guid=6b0e56f5f304e610VgnVCM1000006a8ba8c0____&language=en_US

79 China Mobile HK conducted standalone 5G trials using mid-band spectrum (20MHz of spectrum in the 3.3GHz band, 40MHz in the 4.9GHz band, and 200MHz in the 3.5GHz band) in Hong Kong in December 2019. See https://www.mobileworldlive.com/asia/asia-news/china-mobile-trials-standalone-5g-in-hong-kong/

80 Since March 2019, SmarTone has conducted a number of 5G field tests and has announced the completion of "Hong Kong's first 5G live field trial in both 3.5GHz and 28GHz", aggregating the bands simultaneously. See smartone.com/en/5G/

A.7 Italy

Current assignment: 200MHz of spectrum in the 3.6–3.8GHz range (for nationwide use) and 126MHz of spectrum in the 3.4–3.6GHz range is currently available.

Future assignment: None confirmed at this time.[81]

Overview of mid-band spectrum

In October 2018, the telecom regulator AGCOM held a multi-band 5G auction, which made available two 80MHz blocks and two 20MHz blocks in the 3.6–3.8GHz band on a nationwide basis.

Spectrum in the 3.4–3.6GHz band was auctioned in February 2008 (originally used for the provision of WiMAX services). Three 2×21MHz lots (3.437–3.5/3.537–3.6GHz) were made available on a regional basis.[82] After subsequent license trading, there are currently[83] four main[84] license holders, which currently operate as FWA providers.

Licenses were originally auctioned with a duration of 15 years, expiring in December 2023. In November 2017, AGCOM launched a consultation[85] on extending the licenses (for a fee) by six years to December 2029. Under the terms of the extension, AGCOM proposed, among other things, a reconfiguration of the entire 3.4–3.6GHz band into a TDD arrangement suitable for 5G. Spectrum freed up as a result of this reconfiguration (which is currently occupied by the Ministry of Defense) may be offered to the market. We understand that license extensions were granted in Summer 2018[86] (shortly before the 3.6–3.8GHz auction).[87]

81 The 3.4–3.6GHz band, originally provisioned for WiMAX service may be reconfigured; however, this has not yet been confirmed by the regulator.

82 The lower two blocks (A and B) were auctioned in seven macro-regions, while the upper block (C) was auctioned in 21 sub-regions, meaning that a total of 35 licenses were offered. For details of the different regions, see: https://www.agcom.it/documents/10179/3265296/Allegato+22-1-2018+1516643247616/4be118b1-80af-40ee-9c32-900f739bb21d?version=1.0

83 As of November 2017 (see source above).

84 Three further players also hold a single license each. Brennercom and eolo hold (block C) 2×21MHz licenses in Provincia autonoma di Bolzano and Valle d'Aosta respectively. Mandarin holds a 21MHz TDD license in Sicily.

85 See https://www.agcom.it/documents/10179/3265296/Allegato+22-1-2018+1516643247616/4be118b1-80af-40ee-9c32-900f739bb21d?version=1.0

86 See https://www.edisoninvestmentresearch.com/?ACT=18&ID=22991&LANG=

87 The license extension arrangements were legally challenged by Italian MNOs. However, according to reports, in November 2019, the court ruled in favour of extending the license duration. See https://www.telecompaper.com/news/tim-vodafone-iliad-win-appeal-against-5g-spectrum-extension-for-wimax-providers--1317735

In accordance with the European standard, the 5.15–5.35GHz (indoor only) and 5.47–5.725GHz bands are available for unlicensed use in EU Member States.[88] Furthermore, EU countries are harmonizing the lower part of the 6GHz band (i.e. 5.925–6.425GHz) for unlicensed use.[89]

Operator developments

Two of the four Italian MNOs, TIM[90] and Vodafone[91], have launched commercial 5G services over mid-band spectrum. Wind (with FastWeb)[92] and Iliad[93] have announced plans to deploy 5G networks in 2020; however, the extent to which mid-band spectrum will be used is unclear.

88 See https://www.etsi.org/deliver/etsi_en/301800_301899/301893/02.01.01_60/en_301893v020101p.pdf and https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32005D0513

89 Technical conditions are not expected to be finalized before the end of 2020. Assignment in individual Member States likely to take place in 2021 and beyond. See https://www.ecodocdb.dk/document/10170 and http://apps.cept.org/eccnews/aug-2019/europe_prepares_to_harmonise_the_6_ghz_spectrum_band_for_radio_local_area_networks.html

90 TIM launched commercial 5G services in Rome, Turin, and Naples in the 3.72–3.8GHz range in July 2019. See https://www.ericsson.com/en/news/2019/7/tim-5g-goes-live-in-italy-with-ericsson

91 In June 2019, Vodafone launched commercial 5G services in five cities using 80MHz of 3.7GHz spectrum. Vodafone also has spectrum in the 26GHz band which it will use to provide additional capacity in densely populated areas. Vodafone is aiming to reach 100 cities with its 5G service by 2021. See https://www.proactiveinvestors.co.uk/LON:VOD/Vodafone/rns/LSE20181003070002_13813972 and https://www.vodafone.com/business/news-and-insights/company-news/vodafone-italia-switches-on-5g-in-5-cities

92 Iliad has announced plans to launch its 5G commercial offering in 2020, however it is unclear which bands will be used for initial deployment. Iliad owns spectrum in the 700MHz, 3.7GHz and 26GHz bands. See https://www.nokia.com/sites/default/files/2019-09/CP_020919_Eng.pdf

93 Wind, with FastWeb, has announced plans to launch commercial 5G FWA services in Italy. Wind holds 5G spectrum licenses in the 3.7GHz and 26GHz bands. See https://www.fastweb.it/corporate/landing/5g/?lng=EN

A.8 Japan

Current assignment: The 3.4–3.48GHz range was assigned (for nationwide use) in April 2018. The 3.48–3.6GHz range was assigned (for nationwide use) in December 2018. The 3.6–4.1GHz and 4.5–4.6GHz ranges were assigned (for nationwide use) in April 2019.[94]

Future assignment: The 4.6–4.8GHz range is expected to be awarded in the future for private 5G use. Configuration is likely to be finalized in the second half of 2020.

Overview of mid-band spectrum

Each of the three incumbent MNOs in Japan (i.e. NTT DOCOMO, KDDI, and Softbank) were licensed to use 40MHz of spectrum in the 3.48–3.6GHz range in 2014 on a national basis.[95] The licenses are suitable for mobile use. Furthermore, in April 2018, the 3.44–3.48GHz range was assigned to NTT DOCOMO and the 3.4–3.44GHz range was assigned to Softbank.[96]

In April 2019, the MIC assigned 3.6–4.1GHz and 4.5–4.6GHz ranges for the deployment of nationwide 5G services.[97] Along with the 28.3–29.1GHz spectrum range, the 4.6–4.8GHz range is expected to be awarded in the future for private local 5G licenses.[98] Regulatory approval around the configuration of this band is expected to be finalized in the second half of 2020.[99, 100]

In Japan, the 4.9–5GHz band is available for unlicensed use (registration required).[101] Additional spectrum in the 5.15–5.35GHz (indoor only) and 5.47–5.73GHz bands is also available for unlicensed use.[102]

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94 See http://www.soumu.go.jp/menu_news/s-news/01kiban14_02000378.html

95 See http://www.gtigroup.org/news/ind/2014-12-25/5208.html

96 We understand that Rakuten had previously submitted an application to MIC for 4G suitable spectrum in both the 1.8GHz and 3.4GHz bands (3.4–3.48GHz), however the 3.4GHz spectrum was awarded to Softbank and NTT DOCOMO. See https://www.telegeography.com/products/commsupdate/articles/2018/02/27/japanese-e-tailer-rakuten-submits-application-for-mobile-frequencies/, See http://www.soumu.go.jp/menu_news/s-news/01kiban14_02000333.html

97 See http://www.soumu.go.jp/menu_news/s-news/01kiban14_02000378.html

98 See https://www.gsma.com/spectrum/wp-content/uploads/2018/07/Kohei-Satoh-MWC-Shanghai_MIC-Japan-1.pdf and http://6thglobal5geventbrazil.org.br/wp-content/uploads/2018/11/Panel3-Gaku-Nakazato_MIC-J.pdf

99 See https://www.qualcomm.com/media/documents/files/private-5g-networks-for-industrial-iot.pdf

100 See Section 20 https://ecfsapi.fcc.gov/file/1061035770969/Ex%20Parte%20FINAL%20FINAL%202019%20Submission%20re%203.7-4.2%20GHz%20flex%20use%20docket%20for%20filing.pdf

101 See https://www.tele.soumu.go.jp/j/adm/system/trunk/wimax/5ghz/ and https://www.tele.soumu.go.jp/resource/e/search/myuse/use0303/10000m.pdf

102 See https://wifiamateur.blogspot.com/2013/04/80211ac-device-deployment-in-japan.html and https://www.allied-telesis.co.jp/products/list/wireless/knowl.html

Operator developments

No MNO in Japan has yet launched commercial 5G mobile services using mid-band spectrum.

All four Japanese MNOs, NTT DOCOMO,[103] SoftBank,[104] KDDI,[105] and Rakuten Mobile,[106] have announced plans for commercial 5G launch in the first half of 2020 using a combination of mid-band and high-band frequencies.

Expected date for mid-band spectrum release

Figure A.6: Details of 5G mid-band spectrum assignment in Japan [Source: MIC, 2020]

Category	Details
Spectrum to be released	4.6–4.8GHz for private use
Expected date	Configuration is likely to be finalized in the second half of 2020

103 NTT DOCOMO commenced deployment of its 5G network in September 2019 using its 3.6–3.7GHz, 4.5–4.6GHz, and 28GHz spectrum. Commercial launch is scheduled for Q2 2020; however, pre-commercial services will be available before then. See https://www.rcrwireless.com/20191030/5g/ntt-docomo-offer-5g-45-japanese-prefectures-june-2020-ceo

104 Softbank has scheduled commercial launch using the 3.9–4GHz and 29GHz bands for March 2020. See https://www.telecomasia.net/content/softbank-signs-5g-deals-ericsson-nokia and https://www.japantimes.co.jp/news/2020/03/05/business/tech/softbank-5g-japan-first/

105 KDDI's 5G network deployment will use mid-band (3.7–3.8GHz and 4–4.1GHz) and 28GHz spectrum; commercial launch is expected in March 2020. See https://www.ericsson.com/en/press-releases/2019/9/ericsson-and-kddi-to-deploy-5g-network

106 Rakuten Mobile has announced plans to launch 5G commercial services by June 2020 once its 4G network deployment is completed. Rakuten owns spectrum in the 3.8–3.9GHz and 28GHz bands. See https://www.cnbc.com/2019/08/01/rakuten-to-roll-out-5g-services-by-june-2020-ceo-hiroshi-mikitani.html

A.9 Qatar

Current assignment: A total of 100MHz per operator has been assigned to each of the two MNOs in the 3.4–3.6GHz range.

Future assignment: A document released by CRA in February 2018 indicates that spectrum in the 3.6–3.8GHz range will be assigned for 5G use in the future. CRA is expected to reach a decision on this release by Q3 2021.

Overview of mid-band spectrum

In February 2018, CRA assigned Vodafone and Ooredoo a 100MHz block each in the 3.4–3.6GHz range to allow for the commercial deployment of 5G services.[107,108]

In January 2020, CRA published its draft "Spectrum Outlook 2022",[109] indicating that it plans to make a decision on the 3.6–3.8GHz band by Q3 2021 and will "monitor" the 3.3–3.4GHz band for potential use at the FIFA World Cup in 2022. The 3.8–4.2GHz band has also been designated for "initial investigation" in 2020.

In Qatar, the 5.15–5.35GHz and 5.475–5.8725GHz bands are available for unlicensed (indoor) use for "wireless access systems",[110] however, if the spectrum is to be used for commercial purposes, users are obliged to obtain approval from CRA.

Operator developments

Both Qatari MNOs, Ooredoo and Vodafone, have launched commercial 5G mobile services using mid-band spectrum.[111]

107 See https://www.vodafone.qa/pressrelease/vodafone-first-to-be-live-with-5g-commercially

108 See https://www.rcrwireless.com/20190103/5g/qatar-awards-5g-frequencies-under-new-unified-telecom-licenses

109 See https://cra.gov.qa/en/document/qatar-spectrum-outlook-2022

110 See https://cra.gov.qa/-/media/System/1/B/3/8/1B3807A8A93454349FEC9B56A51E9EE1/Class-License-for-Short-Range-Devices-SRDENG.ashx and https://www.approval.konantech.net/post/qatar-cra-amendment-class-license-for-short-range-devices-srd

111 Ooredoo launched its 5G-NR network in May 2018 using 100MHz of spectrum in the 3.4–3.6GHz range in May 2018. See https://www.ooredoo.com/en/media/news_view/50-ooredoo-5g-network-towers-now-live/

Vodafone launched its commercial 5G network using 100MHz in the 3.4–3.6GHz range shortly afterwards in August 2018. See https://www.rcrwireless.com/20180829/5g/vodafone-activates-commercial-5g-network-qatar and https://www.vodafone.qa/en/investor-relations/news/vodafone-qatar-unveils-the-reach-of-its-5g-network

Expected date for mid-band spectrum release

Figure A.7: Details of 5G mid-band spectrum assignment in Qatar [Source: CRA, 2020]

Category	Details
Spectrum to be released	3.6–3.8GHz (200MHz) planned to be released
Expected date	CRA has indicated that it will assign the 3.6–3.8GHz range to 5G in the future and is likely to come to a decision around release by Q3 2021

A.10 South Korea

Current assignment: South Korea auctioned the 3.42–3.7GHz range on a national basis in June 2018 for 5G use.

Future assignment: In November 2019, MSIT launched its "5G+ spectrum plan" which aims to "secure the world's largest 5G spectrum supply" by releasing an additional 2640MHz of 5G spectrum by 2026. This includes assigning 320MHz in the 3.4–3.42GHz and 3.7–4GHz ranges by 2021, thus making available 600MHz of contiguous spectrum in the mid-band.

Overview of mid-band spectrum

The 3.42–3.7GHz range (along with 2.4GHz of spectrum in the 28GHz band) was auctioned in June 2018.[112]

In November 2019, MSIT launched its "5G+ spectrum plan" which aims to "secure the world's largest 5G spectrum supply" by releasing an additional 2640MHz of 5G spectrum by 2026. This includes assigning 320MHz in the 3.4–3.42GHz and 3.7–4GHZ ranges by 2021.[113] Full details of timeline for assignment have yet to be announced. The additional 320MHz will mean that 600MHz of contiguous mid-band spectrum will be available for 5G services in South Korea.

In South Korea, the 5.15–5.33GHz, 5.49–5.65GHz and 5.735–5.835GHz bands are available for unlicensed use.[114] MSIT's "5G+spectrum plan" aims to make the 6GHz band for available for unlicensed use by 2022, though the exact timeline and spectrum range have not been confirmed (and are subject to global trends).[115]

112 MSIT announced results on June 18, 2018.
See http://www.msit.go.kr/web/msipContents/contentsView.do?cateId=mssw311&artId=1386500

113 See https://www.msit.go.kr/web/msipContents/contentsView.do?cateId=mssw311&artId=2360371

114 See https://web.archive.org/web/20140201183444/

115 See https://www.msit.go.kr/web/msipContents/contentsView.do?cateId=mssw311&artId=2360371

Operator developments

All three South Korean MNOs, SKT,[116] KT,[117] and LG U+,[118] have launched commercial 5G mobile services using mid-band spectrum.

Expected date for mid-band spectrum release

Figure A.8: Details of 5G mid-band spectrum assignment in South Korea [Source: MSIT, 2020]

Category	Details
Spectrum to be released	3.4–3.42GHz and 3.7–4GHz ranges (320MHz) scheduled to be released
Expected date	Expected to be released by 2021

116 SKT launched commercial NSA 5G services using 3.6–3.7GHz spectrum in April 2019 and also announced plans to launch commercial standalone 5G services in H1 2020. See https://www.sktelecom.com/en/press/press_detail.do?page.page=6&idx=1389&page.type=all&page.keyword= and https://www.sktelecom.com/en/press/press_detail.do?page.page=6&idx=1382&page.type=all&page.keyword=

117 KT launched commercial 5G services using 3.5–3.6GHz spectrum in April 2019. See https://corp.kt.com/eng/html/promote/news/report_detail.html?rows=10&page=1&datNo=14719

118 LG U+ launched commercial 5G services using 3.42–3.5GHz spectrum in April 2019. See https://www.ericsson.com/en/press-releases/2019/10/koreas-lg-u-selects-ericsson-as-a-5g-ran-and-5g-core-vendor

A.11 Spain

Current assignment: In June and July 2018, MNO MásMóvil privately acquired two 2×20MHz (80MHz in total) national licenses in the 3.4–3.6GHz band; two of Spain's other MNOs (Orange and Telefónica) already own 2×20MHz national licenses in this band. An auction of 200MHz of spectrum in the 3.6–3.8GHz range (for nationwide use) was completed in July 2018.

Future assignment: None confirmed at this time.

Overview of mid-band spectrum

Three of Spain's MNOs own national licenses in the 3.4–3.6GHz band:[119] Orange (2×20MHz), Telefónica (2×20MHz), and MásMóvil (2×40MHz).[120] Furthermore, MINTEAD completed an auction of the 3.6–3.8GHz range in July 2018.

In accordance with the European standard, the 5.15–5.35GHz (indoor only) and 5.47–5.725GHz bands are available for unlicensed use in EU Member States.[121] Furthermore, EU countries are harmonizing the lower part of the 6GHz band (i.e. 5.925–6.425GHz) for unlicensed use.[122]

Spain has not indicated that further mid-band spectrum is planned for release.

Operator developments

One of the three Spanish MNOs, Vodafone, [123] has launched commercial 5G mobile services using mid-band spectrum.

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119 The exact assignments are as follows: MásMóvil (3.4–3.44/3.5–3.54GHz), Telefónica (3.44–3.46/3.54–3.56GHz), and Orange (3.46–3.48/3.56–3.58GHz). See https://sedeaplicaciones.minetur.gob.es/setsi_regconcesiones/default.aspx. Orange acquired its spectrum at an auction in September 2016 for EUR20 million. See https://www.xatakamovil.com/conectividad/la-subasta-de-nuevo-espectro-para-telefonia-movil-en-los-2-6-ghz-y-3-5-ghz-se-aplaza-a-enero

MásMóvil acquired Neutra Network Services (for EUR15.5 million) in 2018 to gain 2×20MHz (3.42–3.44/3.52–3.54GHz) of spectrum. It also acquired 2×20MHz (3.4–3.42/3.5–3.52GHz) from Eurona Wireless Telecom (for EUR30 million) in 2018. See https://www.eurona.com/en/eurona-culmina-acuerdo-masmovil-licencia-5g-30-millones/ and https://www.mobileworldlive.com/featured-content/top-three/masmovil-secures-5g-boost-with-neutra-network-deal/

120 The remaining 2×20MHz of the 3.4–3.6GHz band is used by the military for radiolocation services; a consultation issued by the regulator MINTEAD in July 2017 indicates that this block is not expected to be reallocated. See http://www.mincotur.gob.es/telecomunicaciones/es-ES/Participacion/Documents/Plan-Nacional-5G.pdf

121 See https://www.etsi.org/deliver/etsi_en/301800_301899/301893/02.01.01_60/en_301893v020101p.pdf and https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32005D0513

122 Technical conditions are not expected to be finalized before the end of 2020. Assignment in individual Member States likely to take place in 2021 and beyond. See https://www.ecodocdb.dk/document/10170 and http://apps.cept.org/eccnews/aug-2019/europe_prepares_to_harmonise_the_6_ghz_spectrum_band_for_radio_local_area_networks.html

123 Vodafone launched commercial 5G services using 90MHz of spectrum in the 3.6–3.8GHz band in June 2019. See http://5gobservatory.eu/wp-content/uploads/2019/10/90013-5G-Observatory-Quarterly-report-5_final.pdf

Both Telefónica and Orange have conducted 5G trials using the mid-band range.[124]

124 Telefónica has been awarded a spectrum license for 50MHz in the 3.6–3.8GHz range. See https://www.telefonica.com/en/web/press-office/-/telefonica-leads-the-way-towards-5g-with-deployments-in-two-spanish-cities

Orange has indicated that it does not expect to launch 5G commercial services until more 5G-appropriate spectrum is available. Orange is likely to augment its 60MHz holding in the 3.6–3.8GHz range with 700MHz, which is likely to become available in March 2020. See https://techblog.comsoc.org/2019/09/25/orange-spain-not-rushing-to-join-the-5g-deployment-scramble-and-reveals-why/ and https://halberdbastion.com/intelligence/news/huawei-orange-spain-test-35-ghz-5g-real-use-environments

A.12 Sweden

Current assignment: 2×40MHz in the 3.62–3.66/3.72–3.76GHz spectrum range has been assigned to MNOs on a national basis (expiring in December 2022). Some regional licenses have also been assigned in the remainder of the 3.4–3.8GHz band.

Future assignment: PTS is planning to award the 3.42–3.72GHz range to mobile (alongside the 2.3–2.38GHz range) in October 2020. The 3.72–3.8GHz band is planned for local use (e.g. for private 5G networks) and is scheduled to be released from 2023 onward.

Overview of mid-band spectrum

Two MNOs in Sweden own national[125] 2×20MHz licenses in the 3.62–3.66/3.72–3.76GHz range (i.e. a total of 2×40MHz). The remaining spectrum in the 3.6–3.8GHz band has been made available via auction on a regional basis, though most licenses have not been assigned. These licenses are technology and service neutral and expire in December 2022. The 3.41–3.438GHz and 3.51–3.538GHz ranges are currently assigned on a regional basis to several local operators[126]; licenses are technology neutral and expire in March 2023.[127]

In February 2018, PTS published[128] a consultation on the release of the 3.4–3.8GHz band for 5G. PTS subsequently confirmed[129] its intention to assign the 3.4–3.7GHz range on a nationwide basis in late 2019 or early 2020, and the 3.7–3.8GHz range on a local basis from 2023.

125 In 2007, PTS auctioned four 40MHz blocks (two FDD in the 3.6–3.64/3.7–3.74GHz range and two TDD at 3.66-3.7GHz and 3.76-3.8GHz) in the 3.6–3.8GHz band in each of Sweden's 290 municipalities. B2 Bredband (owned by Telenor) won the upper FDD block (i.e. 3.62–3.64/3.72–3.74GHz) in every municipality, meaning that it effectively holds a national license of 2×20MHz. Of the remaining 870 licenses, the majority (758) remained unsold and were re-auctioned in 2009. 265 of these licenses are now assigned; these licenses are spread out geographically across the country (most assigned licenses are in the more northerly municipalities). The 2009 auction also made available a national 2×20MHz block (3.64–3.66/3.74–3.76GHz), which was won by TDC Sverige (owned by Tele2). All licenses expire in December 2022 and are technology and service neutral. See February 2018 consultation.

126 The licenses in the 3.4–3.6GHz band were originally assigned on a county basis, but the charging base for the annual fees comprises population by municipality. Licenses expire in March 2023. There are licenses assigned in 98 out of 290 municipalities. We understand that the majority of license holders are not using their licenses (see February 2018 consultation). On October 16, 2018, PTS announced that it had asked all licensees that were not using (or lightly using) their licenses to return them to the regulator. See https://www.pts.se/sv/nyheter/radio/2018/pts-vill-att-kommunala-frekvenstillstand-i-35-ghz-bandet-lamnas-tillbaka/

127 Until recently, two MNOs in Sweden owned national licenses in the 3.4-3.6GHz band: Telia-Sonera (3.438–3466GHz, 3.538–3.566GHz) and Tele2 (3.466–3.494GHz, 3.566–3.594GHz). These licenses expired in December 2017, and PTS chose not to re-auction the spectrum in view of making the wider 3.4-3.8GHz band available.

128 See https://www.pts.se/contentassets/9057a944959742878f4b3ce0e7ade9f7/remiss-av-rapport-infor-framtida-tilldelning-av-frekvenser-for-5g/forstudie-frekvenser-5g-remissrapport.pdf (English version also available).

129 See https://pts.se/globalassets/startpage/dokument/listningar-pa-textsidor/35-ghz/infomote-21-sep.pdf

After several further consultations,[130] in February 2020 PTS published a final consultation on the auction of the 3.42–3.72GHz band[131] (alongside the 2.3–2.38GHz band). The auction is scheduled to take place in October 2020. In most locations, spectrum will become available for use upon issue of licenses. However, in certain locations (for certain portions of the band), use will be limited until incumbent licenses expire (in 2022/23 – see above).

In December 2019, PTS opened the 3.6–3.8GHz and 3.8–4.2GHz bands (in addition to the 3.4–3.6GHz band already available) for 5G testing.[132]

In accordance with the European standard, the 5.15–5.35GHz (indoor only) and 5.47–5.725GHz bands are available for unlicensed use in EU Member States.[133] Furthermore, EU countries are harmonizing the lower part of the 6GHz band (i.e. 5.925–6.425GHz) for unlicensed use.[134]

Operator developments

No MNO in Sweden has yet launched commercial 5G mobile services using mid-band spectrum.

Telia has said that it plans to launch 5G services as soon as mid-band spectrum has been assigned.[135]

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130 In February 2019, PTS opened a consultation on the 2.3GHz and 3.4–3.72GHz bands.

In June 2019, PTS opened a consultation on the terms and conditions for the award of the 2.3GHz and 3.4–3.72GHz bands. PTS also proposed assigning 80MHz in the 3.72–3.8GHz range for local licenses.

In November 2019, PTS announced that the 2.3GHz and 3.4–3.72GHz 5G spectrum auction would be delayed and take place after Q1 2020, due to a current update of the Electronic Communications Act (LEK) that focuses on Sweden's security around 5G technology.

In December 2019, PTS confirmed that a consultation on auction rules for the 2.3GHz and 3.4–3.72GHz bands would be published in Q1 2020.

In February 2020, PTS opened a final consultation on the 2.3GHz and 3.4–3.72GHz bands; responses are due by March 2020.

For an index of relevant documentation, see https://www.pts.se/sv/bransch/radio/auktioner/3-5-ghz-bandet/

131 The 3.42–3.72GHz range will be auctioned in fifteen 20MHz blocks; the 3.4–3.42GHz block (use of which is limited) will be automatically assigned to the winner of the 3.42–3.44GHz block. The 3.4–3.42GHz block has not been counted in our tallies.

132 See https://www.pts.se/sv/nyheter/radio/2019/pts-mojliggor-5g-tester-i-fler-frekvensband/

133 See https://www.etsi.org/deliver/etsi_en/301800_301899/301893/02.01.01_60/en_301893v020101p.pdf and https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32005D0513

134 Technical conditions are not expected to be finalized before the end of 2020. Assignment in individual Member States likely to take place in 2021 and beyond. See https://www.ecodocdb.dk/document/10170 and http://apps.cept.org/eccnews/aug-2019/europe_prepares_to_harmonise_the_6_ghz_spectrum_band_for_radio_local_area_networks.html

135 Tele2 and Telenor formed a joint venture, NetMobility to deploy a consolidated 5G network, with a commercial launch planned for 2020. NetMobility won 700MHz spectrum in the December 2018 auction. See https://www.tele2.com/media/press-releases/2018/tele2-and-telenor-secure-new-frequencies-and-consolidate-joint-plan-for-5g-network-in-sweden.

Telia, along with Ericsson, launched the first 5G trial in Sweden in December 2018 on the KTH campus. The network is used as a 5G test bed as Telia works toward a commercial 5G launch later in 2020. See https://www.ericsson.com/en/press-releases/2018/12/swedens-first-5g-network-is-live-at-kth-royal-institute-of-technology. In December 2019, Telia said that it would launch 5G "as soon as the [3.5GHz]

Expected date for mid-band spectrum release

Figure A.9: Details of 5G mid-band spectrum assignment in Sweden [Source: PTS, 2018]

Category	Details
Spectrum to be released	300MHz (3.42–3.72GHz) for nationwide use 80MHz (3.72–3.8GHz) for local use
Expected date	3.42–3.72GHz: auction proposed for October 2020 3.72–3.8GHz: to be made available from 2023 onward

frequencies have been assigned". See https://www.teliacompany.com/en/news/news-articles/2019/4g-birthday/

A.13 UK

Current assignment: The UK completed the auction of 150MHz of 3.4–3.6GHz spectrum in June 2018. In July 2019, Ofcom announced new geographical separation spectrum licensing arrangements in the 3.8–4.2GHz band. Local licenses will be assigned by Ofcom on a FCFS basis.[136] MNO Three also holds various mid-band spectrum licenses on a national basis through its acquisition of UK Broadband.

Future assignment: The UK anticipates awarding 120MHz of spectrum in the 3.68–3.8GHz range in H2 2020.

Overview of mid-band spectrum

FWA operator UK Broadband (now owned by MNO Three) owns national licenses in the 3.48–3.5GHz, 3.58–3.6GHz,[137] 3.6–3.68GHz,[138] and 3.925–4.009GHz[139] mid-band ranges.

In April 2018, Ofcom completed an auction of 150MHz in the 3.4–3.6GHz band.[140]

In December 2018, Ofcom published a consultation[141] on its proposal to conduct a combined auction of spectrum in the 700MHz and 3.6–3.8GHz ranges (excluding the 80MHz already licensed to UK

136 See https://www.ofcom.org.uk/__data/assets/pdf_file/0033/157884/enabling-wireless-innovation-through-local-licensing.pdf

137 In June 2003, the Radiocommunications Agency (RA) held a regional 3.4–3.6GHz FWA auction. Two 20MHz TDD blocks (3.480–3.5GHz and 3.580–3.6GHz) were made available under a single license in each of 15 regions; the 15 regions collectively covered the entirety of the UK. Poundradio (which changed its name to UK Broadband shortly after the auction) won licenses in 13 out of the 15 regions. It subsequently acquired the remaining two licenses by buying the companies (Red Spectrum and Public Hub) that won them in the auction. In March 2007, Ofcom agreed to combine UK Broadband's licenses into a single nationwide license. Later in 2007, UK Broadband successfully requested a variation to its license conditions to allow technology and application neutrality (thereby allowing mobile as well as FWA use). In June 2014, Ofcom extended the duration of the license to be indefinite (the original licenses expired after 15 years). See https://www.ofcom.org.uk/research-and-data/telecoms-research/broadband-research/oftel_internet_broadband_brief https://www.ofcom.org.uk/consultations-and-statements/category-2/uk-broadband-licence

138 This license was previously for 3.605–3.689GHz. On June 27, 2018, Ofcom published a consultation on varying UK Broadband's license in this range. UK Broadband requested to shift its license to 3.6–3.68GHz and change the applicable technical conditions. The request was granted by Ofcom on December 14, 2018. See:

https://www.ofcom.org.uk/__data/assets/pdf_file/0028/96913/UK-Broadband.pdf
https://www.ofcom.org.uk/consultations-and-statements/category-2/variation-uk-broadbands-spectrum-access-licence-3.6-ghz
https://www.ofcom.org.uk/__data/assets/pdf_file/0014/130253/Statement-UK-Broadbands-spectrum-access-licence-3.6-GHz.pdf

139 Unlike UK Broadband's other mid-band spectrum licenses, this license is for FWA only, and allows individual deployments on a first-come, first-served basis, subject to co-ordination by Ofcom (with incumbent satellite Earth stations and fixed links).

140 The 3.4–3.6GHz range was auctioned, excluding the two 20MHz TDD portions already licensed to UK Broadband, and a guard band at 3.4–3.41GHz. Licenses are nationwide and technology neutral. See https://www.ofcom.org.uk/spectrum/spectrum-management/spectrum-awards/awards-archive/2-3-and-3-4-ghz-auction

141 See https://www.ofcom.org.uk/consultations-and-statements/category-1/award-700mhz-3.6-3.8ghz-spectrum.

Broadband[142]). In October 2019, Ofcom released an updated proposal[143] for this auction; Ofcom "hope to be in a position to start the auction by Spring 2020".[144]

In July 2019, Ofcom published a decision paper on "Shared access to spectrum supporting mobile technology", opening up the 3.8–4.2GHz band for geographical separation spectrum licensing (intended to encourage new innovative uses).[145] Applications are currently open; Ofcom will assign local licenses on a "per location, first come, first served" basis.

In accordance with the European standard, the 5.15–5.35GHz (indoor only) and 5.47–5.725GHz bands are available for unlicensed use in EU Member States (including the UK).[146] The UK has also made the 5.725–5.85GHz band available for unlicensed use.[147] In January 2020, Ofcom published a consultation on making the lower 6GHz band (5.925–6.425GHz) available for unlicensed use. Responses are due by March 2020.[148]

Three further documents were published on January 31, 2019, relating to the 700MHz and 3.6–3.8GHz auction:

(1) Ofcom's approach to verifying compliance [with the coverage obligations]
(2) Proposals to make a limitation order and amend the mobile trading and the register regulations
(3) Proposals to make the auction regulations

See:

https://www.ofcom.org.uk/consultations-and-statements/category-2/coverage-obligations-in-the-700-mhz-and-3.6-3.8-ghz-spectrum-award
https://www.ofcom.org.uk/consultations-and-statements/category-2/regulations-award-700-mhz-3.6-3.8-ghz
https://www.ofcom.org.uk/consultations-and-statements/category-2/proposal-auction-regulations-700mhz-3.6-3.8-ghz

142 That is, 3.6–3.68GHz.

143 See https://www.ofcom.org.uk/__data/assets/pdf_file/0028/172648/revised-proposal-auction-design.pdf

144 The 3.68–3.8GHz spectrum to be auctioned "should become available for mobile use across the country by June 2020. Some localised constraints may remain in place until the end of 2022".

145 The spectrum is available across the country, though there are exclusion zones in certain areas for satellite earth stations. There are two types of license – a lower power license (potential uses: industrial and enterprise private networks and/or indoor mobile coverage extensions) and a medium power license (potential uses: industrial users with distributed sites, like ports, railyards, or large factories, and rural FWA).

See https://www.ofcom.org.uk/__data/assets/pdf_file/0033/157884/enabling-wireless-innovation-through-local-licensing.pdf

146 See https://www.etsi.org/deliver/etsi_en/301800_301899/301893/02.01.01_60/en_301893v020101p.pdf and https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32005D0513

147 See https://www.ofcom.org.uk/__data/assets/pdf_file/0032/98159/5p8-Regs.pdf

148 See https://www.ofcom.org.uk/__data/assets/pdf_file/0038/189848/consultation-spectrum-access-wifi.pdf

Operator developments

All four MNOs in the UK, EE,[149] Vodafone,[150] O2[151] and Three[152], have launched commercial 5G mobile services using mid-band spectrum.

Expected date for mid-band spectrum release

Figure A.10: Details of 5G mid-band spectrum assignment in the UK [Source: Ofcom, 2020]

Category	Details
Spectrum to be released	120MHz in the 3.6–3.8GHz range 3.8–4.2GHz via geographical separation spectrum licensing arrangements
Expected date	3.6–3.8GHz: award planned for the second half of 2020. Under the expected timeline for migration of incumbent users, spectrum in certain locations will not be available for use until the end of 2022 3.8–4.2GHz: applications are currently open for local licenses

149 EE launched 5G commercial services in the UK in May 2019 using its 3.54–3.58GHz spectrum. See https://newsroom.ee.co.uk/ee-launching-uks-first-5g-service-in-six-cities-bringing-a-new-era-in-faster-more-reliable-connectivity/. EE has trialed using the 1800MHz band to provide 5G uplink. See https://www.mobileeurope.co.uk/press-wire/ee-and-vodafone-demo-uplink-sharing-in-5g-trials

150 Vodafone launched commercial mobile 5G services in July 2019 using spectrum in the 3.41–3.46GHz range. See https://newscentre.vodafone.co.uk/press-release/5g-unlimited-data-more-places-than-any-other-network/

151 O2 launched commercial mobile 5G services in October 2019 using spectrum in the 3.5–3.54GHz range. See https://news.o2.co.uk/2019/10/17/o2-switches-on-5g-with-unlimited-data-flexible-plans-and-no-premium-4/

152 Three launched commercial FWA 5G services in August 2019 using 100MHz of spectrum in the 3.58–3.68GHz range. It originally scheduled its mobile 5G launch for the end of 2019, but this was subsequently delayed until early 2020. On February 14, 2020, Three announced that it would launch commercial mobile 5G services (initially using the 3.58–3.68GHz range) in 65 locations by the end of February 2020. See http://www.threemediacentre.co.uk/news/2019/19-08-2019a.aspx and http://www.threemediacentre.co.uk/news/2020/14-02-2020.aspx

A.14 US

Current assignment: The US does not currently have any spectrum assigned in the 3–7GHz range on a traditional licensed basis. However, in 2019, 80MHz of spectrum in Tier 3 of the CBRS band became available on a shared basis.

Future assignment: The US is making 70MHz of licensed spectrum available in the CBRS band, which is expected to be auctioned in mid-2020 on a wide-area (county) basis. An auction of the 3.7–3.98GHz band is scheduled to begin in December 2020.

In December 2019, the FCC announced that it was also preparing the 3.3–3.55GHz band for possible expanded commercial use, and NTIA is required by statute to explore the feasibility of allowing commercial wireless services, licensed or unlicensed, to share use of the 3.1–3.55GHz band. There are currently no timeframes for the potential availability of this spectrum.

Overview of mid-band spectrum

The FCC is in the process of releasing the citizens broadband radio service (CBRS) band (3.55–3.7GHz) for shared wireless broadband use.[153] In 2019, 80MHz of spectrum in Tier 3 of the CBRS band became available.[154] The US is making 70MHz of licensed spectrum in the CBRS band available, which is expected to be auctioned in mid-2020 on a wide-area (county) basis, with power levels notably lower than traditional 4G service.[155]

In February 2020, FCC Chairman Pai announced[156] he would seek to hold an auction (beginning in December 2020) of 280MHz of spectrum in the 3.7–3.98GHz range[157]; the lower 100MHz could become available by September 2021 and the remaining 180MHz could become available by September 2023.[158]

In December 2019, the FCC announced that it was also proposing steps to prepare the 3.3–3.55GHz[159] band for "advanced commercial services, including 5G". More specifically, the FCC is

153 See https://www.fcc.gov/rulemaking/12-354#block-menu-block-4 for an index of FCC CBRS documentation.

154 Tier 3 is often referred to as unlicensed, but users are licensed-by-rule (i.e. they must meet the FCC's technical, financial, character, and citizenship qualifications to be eligible). See https://www.fcc.gov/wireless/bureau-divisions/mobility-division/35-ghz-band/35-ghz-band-overview

155 See https://www.fcc.gov/auction/105

156 See https://docs.fcc.gov/public/attachments/DOC-362335A1.pdf and https://docs.fcc.gov/public/attachments/DOC-362358A1.pdf

157 The 3.98–4GHz range will serve as a guard band, while incumbent satellite licensees in the C-band (3.7–4.2GHz) will be repacked into the 4–4.2GHz range.

158 Incumbent satellite licensees are required to vacate the spectrum by September 2025, however, they will be eligible for "accelerated relocation payments" if they vacate the spectrum according to an accelerated timeline, namely: (1) vacating 100MHz (3.7–3.8GHz) by September 2021, and (2) vacating the remaining 180MHz (3.8–3.98GHz) by September 2023.

159 See https://docs.fcc.gov/public/attachments/DOC-361340A1.pdf

considering the reallocation of non-federal users in the 3.3–3.55GHz range to the 3.1–3.3GHz range or other frequencies. There are currently no timeframes for the potential availability of this spectrum.

In the US, the 5.15–5.35GHz and 5.47–5.85GHz bands are available for unlicensed use.[160] In December 2019, the FCC adopted a consultation which proposes to designate the 5.85–5.895GHz band for unlicensed use.[161] In October 2018, the FCC proposed rules to allow unlicensed use in the 5.925–7.125GHz band. The final rules are still to be decided.[162]

Operator developments

No MNO in the US has yet launched commercial 5G mobile services using mid-band spectrum in the 3–7GHz range.[163]

160 See https://apps.fcc.gov/kdb/GetAttachment.html?id=1K3EcgPRatUcWMwkA%2BuROw%3D%3D&desc=905462%20D06%20802%2011%20Channel%20Plans%20%20New%20Rules%20v02&tracking_number=27155

161 See https://docs.fcc.gov/public/attachments/DOC-361339A1.pdf and https://www.federalregister.gov/documents/2020/02/06/2020-02086/use-of-the-5850-5925-ghz-band

162 Under the FCC's proposal, the 5.925–6.425GHz and 6.525–6.875GHz sub-bands, unlicensed devices would only be allowed to transmit under the control of an automated frequency control (AFC) system. In the 6.425–6.525GHz and 6.875–7.125GHz sub-bands, unlicensed devices would be restricted to indoor use and would operate at lower power, without an AFC system. See https://docs.fcc.gov/public/attachments/DOC-354364A1.pdf. Some entities are seeking access to the full band for low-power indoor and very low power indoor/outdoor unlicensed operations without use of an AFC, while other entities have argued that protection of critical incumbents in the band necessitates application of an AFC across all sub-bands.

163 In mid-2019, AT&T launched 5G trials using spectrum in the 4.4–5GHz band. The MNO launched commercial 5G services in December 2018 using spectrum in the 850MHz band. See https://about.att.com/story/2019/5g_launch.html, https://www.fiercewireless.com/5g/at-t-to-launch-5g-for-consumers-using-low-band-850-mhz-spectrum and https://techblog.comsoc.org/2019/07/31/att-tests-5g-transmission-on-mid-band-sub-6ghz-and-later-low-band-700mhz-spectrum/

In May 2019, Sprint launched commercial 5G services using spectrum in the 2.5GHz band. See https://newsroom.sprint.com/sprint-lights-up-true-mobile-5g-in-atlanta-dallas-fort-worth-houston-and-kansas-city.htm

In December 2019, T-Mobile announced availability of nationwide commercial 5G services using its 600MHz spectrum. https://www.t-mobile.com/news/americas-first-nationwide-5g-network

In April 2019, Verizon launched its commercial 5G network using the 28GHz and 39GHz mm-wave spectrum bands. See https://www.verizon.com/about/our-company/5g/understanding-5g-spectrum

Expected date for mid-band spectrum release

Figure A.11: Details of 5G mid-band spectrum assignment in the US [Source: FCC, 2020]

Category	Details
Spectrum to be released	Tier 2 of the CBRS band (70MHz within the 3.55–3.65GHz range) is scheduled for auction 3.7–3.98GHz is scheduled for auction 3.1–3.55GHz is being considered for release, but no further details or timeline have yet been confirmed
Expected date	Tier 2 of the CBRS band: scheduled to be auctioned in June 2020 3.7–3.98GHz: scheduled to be auctioned in December 2020. Lower 100MHz likely to be available by September 2021, and remaining 180MHz by September 2023[164]

164 As noted above, incumbent licensees are required to vacate the 3.7–3.98GHz range by September 2025. However, incumbent licensees will be eligible for "accelerated relocation payments" is they vacate the spectrum according to an accelerated 2021/2023 timeline.

Annex B Abbreviations used in this report

ACMA	Australian Communications and Media Authority (Australian NRA)
AGCOM	Autorità per le Garanzie nelle Comunicazioni (Italian NRA)
ANFR	Agence Nationale des Fréquences
ARCEP	Autorité de Régulation des Communications Électroniques et des Postes (French NRA)
BNetzA	Bundesnetzagentur (German NRA)
CA	Communications Authority (Hong Kong NRA)
CBN	China Broadcasting Network
CBRS	Citizens Broadband Radio Service
CNMC	Comisión Nacional de los Mercados y la Competencia (Spanish NRA)
CRA	Communications Regulatory Authority (Qatari NRA)
FCC	Federal Communications Commission (US NRA)
FCFS	First Come First Served
FDD	Frequency Division Duplex
FWA	Fixed-Wireless Access
GSMA	GSM Association
HD	High Definition
ISED	Department for Innovation, Science and Economic Development (Canadian NRA)
LTE	Long Term Evolution
MIC	Ministry of Internal Affairs and Communications (Japanese NRA)
MIIT	Ministry of Industry and Information Technology (Chinese NRA)
MIMO	Multiple Input, Multiple Output
MINTEAD	Ministry of Energy, Tourism and Digital Agenda (Spanish NRA)
MSIT	Ministry of Science and ICT (South Korean NRA)
mm-wave	Millimeter-wave
MNO	Mobile Network Operator
NRA	National Regulatory Authority
NR	New Radio
NSA	Non-standalone
NTIA	National Telecommunications and Information Administration
OFCA	Office of the Communications Authority (Hong Kong NRA)
Ofcom	Office of Communications (UK NRA)
PTS	Post- och telestyrelsen (Swedish NRA)

SA	Standalone
SAS	Spectrum Access System
SCED	Secretary for Commerce and Economic Development (Hong Kong)
TDD	Time Division Duplex
THD	Très Haut Débit (Very High Speed)
WiMAX	Worldwide Interoperability for Microwave Access
2G/3G/4G/5G	Second/Third/Fourth/Fifth Generation of mobile technology
5G-NR	5G New Radio