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Comparison of total mobile spectrum in different markets

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This study examines licensed and unlicensed terrestrial wireless spectrum in 15 leading markets

- CTIA commissioned Analysys Mason to produce an updated analysis on total terrestrial wireless spectrum (licensed and unlicensed) in different markets
- The study provides an update to Analysys Mason's report on 'Comparison of total mobile spectrum in different markets', prepared for CTIA in June 2020[1]
- The study covers a revised list of 15 leading markets across all three ITU regions (see table opposite), and captures licensed and unlicensed mobile spectrum availability in:[2]
  - low bands (below 3GHz)
  - mid bands (between 3GHz and 7GHz)
  - high bands (in the millimeter-wave (mmWave) region)
- Current spectrum assignments are included as well as planned future assignments that are expected to take place within the next five years[3]
- Data is based on the most recently published information available from national regulatory authorities (NRAs) and relevant government agencies:
  - this has been supplemented by other sources where appropriate (for example, WRC and ITU documentation, information provided by regional spectrum organizations such as APT and CEPT, and standards organizations such as ETSI and 3GPP)

Markets covered in the study

ITU Region	Markets
ITU Region 1	France
	Germany
	Italy
	Saudi Arabia[1]
	Spain
	Sweden
	UK
ITU Region 2	Brazil[1]
	Canada
	US
ITU Region 3	Australia
	China
	Hong Kong
	Japan
	South Korea

[1] https://mma.prnewswire.com/media/1198471/Final_report_for_CTIA_Analysys_Mason.pdf?p=pdf

[2] While there is no set rule for dividing between low-, mid-, and high-band spectrum, we have chosen dividing lines that best reflect the recent assignment decisions made by policymakers with knowledge of forthcoming 5G service deployments. For example, we selected 3GHz as the dividing line between low- and mid-band spectrum. The 2.5GHz band (first assigned about two decades ago) shares many of the same characteristics of the identified mid-band spectrum (e.g., large bandwidth, use of time division duplexing, and propagation characteristics), and could therefore properly be grouped with mid-band spectrum as well. The focus of this report is on evaluation of more recent and future spectrum assignment decisions

[3] We generally exclude spectrum that has been consulted on but no specific timeline for assignment has been proposed

[4] New market covered in this study (not included in our previous report)

Key findings

Low bands

- The US currently leads the benchmark countries in terms of licensed low-band spectrum, with a total of 752MHz available
- Within the next five years, three other countries are expected to overtake the US, which will trail these leading countries by 70MHz on average
- Other countries that have plans to release licensed low-band spectrum will add 105MHz on average, while the US plans to add up to 28.5MHz

Mid bands

- With 270MHz, the US trails the leading three countries in terms of licensed mid-band spectrum, by 530MHz on average
- Within the next five years, other countries will continue to lead the ranking. The US will have 450MHz of licensed mid-band spectrum available, trailing the leading three countries (excluding China) by 415MHz on average[1]
- The US currently leads in terms of unlicensed mid-band spectrum with 1905MHz available, including the entire 6GHz band. This is around double the amount available in the UK, Hong Kong, Japan, Australia, France, Germany, Spain, and Sweden, and nearly six times more than China
- Only two out of the 15 benchmark countries plan to make more unlicensed mid-band spectrum available. The US is the only benchmark country which has made unlicensed or lightly licensed spectrum available in the 3.3–4.2GHz range

High bands

- The US is second to Australia in terms of licensed high-band spectrum, with a total of 4950MHz available
- Within the next five years, five other countries are expected to overtake the US by an average of 1930MHz
- Across the mid and high bands, the US today has made over three times as much unlicensed spectrum as licensed spectrum available (16 505MHz of unlicensed spectrum vs. 5220MHz of licensed spectrum)

Note: average figures rounded to the nearest 5MHz; [1] If China is included, then the average gap is 735MHz instead of 415MHz. (China is considering whether/how to use the 6GHz band for mobile, though no definitive approach or timeline has been announced. We understand that China has considered making the full 6GHz band available for mobile on a licensed basis.)

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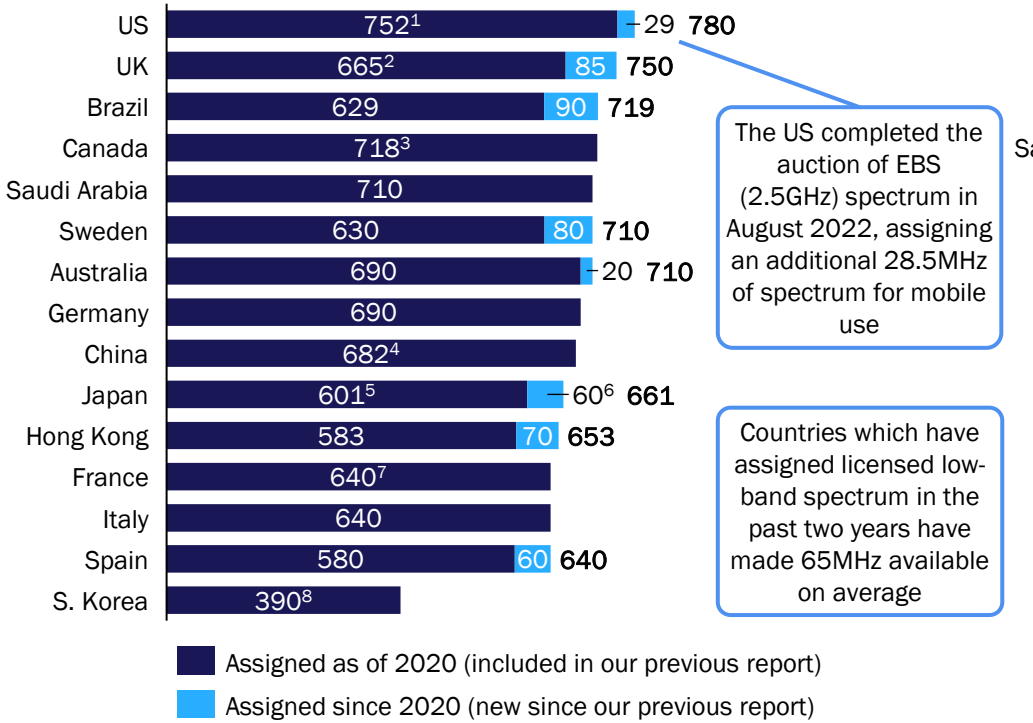
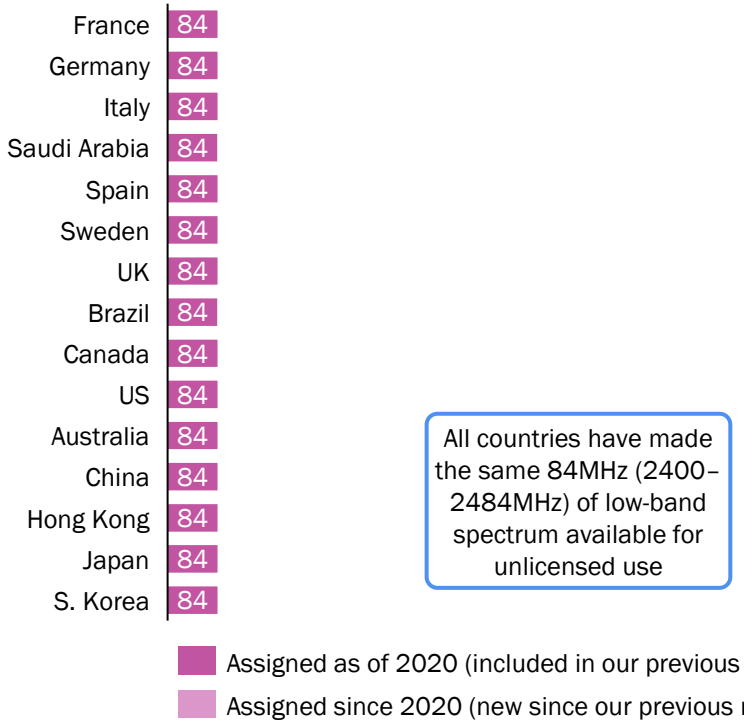
The US currently leads the benchmark countries in terms of licensed low-band mobile spectrum

Licensed low-band spectrum currently assigned for mobile use (total MHz)



Unlicensed low-band spectrum currently assigned for mobile use (total MHz)

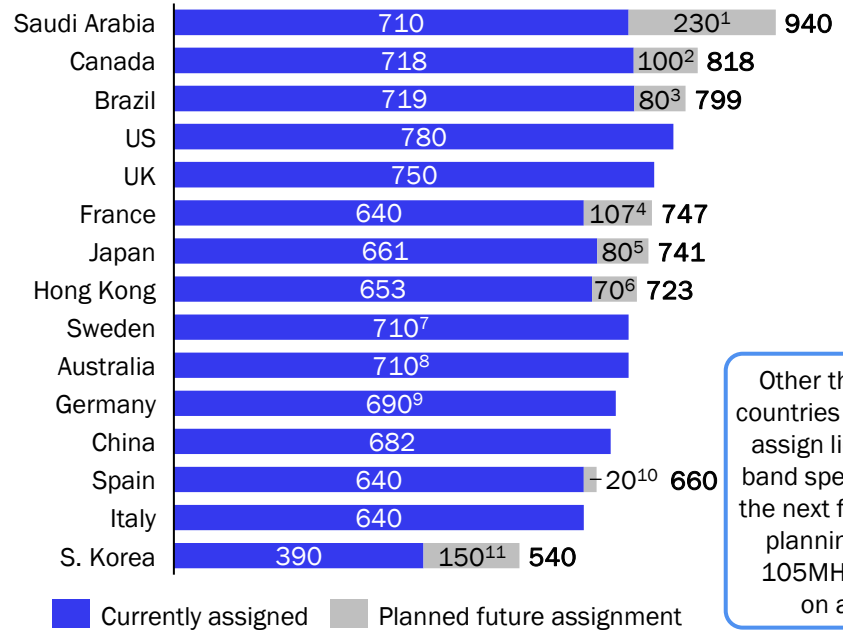


[1] This includes 30MHz of spectrum for use by ancillary terrestrial component (ATC) services (in April 2020, the Federal Communications Commission (FCC) authorized Ligado Networks to deploy a low-power nationwide terrestrial network in the 1526–1536MHz, 1627.5–1637.5MHz, and 1646.5–1656.5MHz bands); [2] This includes 16.6MHz of 'shared access' spectrum in the 1.8GHz and 2.3GHz bands which is available for local licensing (of which 10MHz was not included in our previous report). Additionally, the full 2.5GHz band has been assigned, but 15MHz is restricted (a consultation to change this to 10MHz is currently underway, and this change is reflected in the chart); [3] Note that we have excluded the 100.5MHz of mobile satellite radiocommunication service (MSS) spectrum in Canada which is available for ATC use in the 1525–1559/1626.6–1660.6MHz and 1610–1626.5/2483.5–2500MHz bands (since we understand that this spectrum is primarily held by MSS operators); [4] This includes 20MHz in the 2.3GHz band that was not included in our previous report; [5] This includes 31.2MHz of personal handy-phone system (PHS) spectrum in the 1884.5–1915.7MHz range; [6] 20MHz (2575–2595MHz) is for mobile/fixed communication in rural areas and for local private 5G; [7] 40MHz (2575–2615MHz) is for private use; [8] There is 20MHz less in the 850MHz band vs. our previous report (CDMA800 shut-down) and 10MHz less in the 1800MHz band

Source: NRAs, Analysys Mason

In five years, the US may be overtaken by a handful of countries (such as Saudi Arabia, Brazil, and Canada) as further low-band licensed spectrum is assigned

Currently assigned spectrum and planned future assignments of licensed low-band spectrum suitable for mobile use (total MHz)



Other than the US, countries with plans to assign licensed low-band spectrum within the next five years are planning to make 105MHz available on average

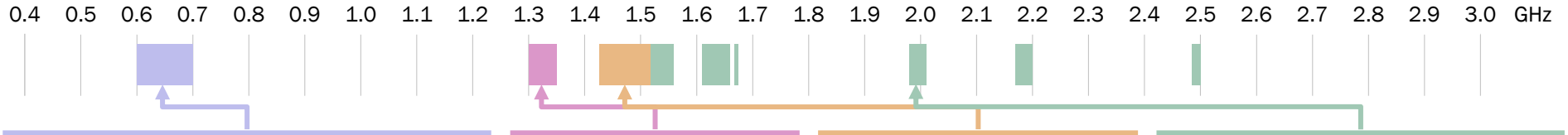
Currently assigned spectrum and planned future assignments of unlicensed low-band spectrum suitable for mobile use (total MHz)

[1] This includes 10MHz in the 400MHz band (for specialized radio network for civil entities), 70MHz in the 600MHz band, 40MHz in the 700MHz band, 80MHz* in the 1500MHz band, and 30MHz of ATC spectrum in the S-band (1995–2010/2170–2185MHz), which will be made available for air-to-ground use, with the option to upgrade for IMT use in the future; [2] This includes 20MHz in the 850MHz band and 80MHz* in the 1500MHz band; [3] This includes 80MHz* in the 1500MHz band; [4] 90MHz in the 1500MHz band, no further update on 15MHz in 700MHz SDL, and 1.6MHz in 2.1GHz following removal of guard band; [5] 60MHz in 2.1GHz and 20MHz in 2.5GHz are being considered for dynamic spectrum sharing; [6] 70MHz in the 600MHz band (for indoor use) was not acquired in the auction held in October 2021 (the spectrum has been reserved and is available for release to the market subject to expression of interest from the industry); [7] 91MHz in the 1500MHz band is due to be assigned, but no timeframe has been announced yet; [8] We have excluded 50MHz of ATC spectrum in the S-band (1980–2005/2170–2195MHz), which must be used in conjunction with MSS; [9] Germany has decided not to assign 15MHz in the 700MHz band until a later date; [10] 20MHz in the 2370–2400MHz band to be assigned for private 5G networks; 40MHz in the 1500MHz band is also being considered for assignment but no timeframe has been specified; [11] 40MHz in the 700MHz band, 30MHz in the 800MHz band, and 80MHz in the 2300MHz band

*Reduced from 91MHz (the full extended L-band) to account for guard bands etc.

The 600MHz band, the L-band, and ATC spectrum around 1–2GHz are being considered for mobile use in certain countries, with significant variations by region

Further low-band spectrum at the early stages of consideration for mobile/IMT harmonization or allocation



Band: 600MHz

The 600MHz band has already been identified for mobile/IMT use in certain countries. Saudi Arabia will make the band available for mobile use shortly. Hong Kong auctioned the band for indoor use in October 2021, but no spectrum was sold (the spectrum has been reserved and is available for release to the market subject to expression of interest from the industry). India auctioned the 600MHz band in August 2022 but received no bids. Many other countries are monitoring international developments (e.g., the transition of consumer viewing habits from digital terrestrial television to other platforms)

The 470—960MHz band will be considered for mobile use in Region 1 at WRC-23, and there is broad support from mobile network operators (MNOs) for a co-primary mobile allocation in the 600MHz band in Europe. However, time would be needed to change use of this band in Europe from broadcasting to mobile

The US and Canada are the two markets that have made the 600MHz band available for mobile use to date (both using a 2×35MHz band plan in the 617–652/663–698MHz range)

Band: 1300–1350MHz

This band is currently allocated for radionavigation and radiolocation

Resolution 250 from WRC-19 proposes a preliminary agenda item for WRC-27 on land mobile systems in the 1300–1350MHz band

In the US, the band is currently used primarily for federal radars, with some minimal non-federal radar use, and is under study by the Federal Aviation Administration, the Department of Defense, and the Department of Homeland Security for sharing with wireless services. These agencies are examining the feasibility of auctioning 50MHz (1300–1350MHz) by 2024

Band: 1427–1518MHz (L-band)

Four markets within our benchmark group (Germany, Italy, Japan, and the UK) have already assigned portions of the L-band for mobile use

Four markets (Canada, France, Saudi Arabia and Brazil) have plans to assign the entire band for mobile use

Other markets (Spain and Sweden) are considering making available some, or all, of the band for mobile use, and in some cases determining assignment mechanisms

Some markets (such as Australia) have no current plans to assign the L-band for mobile use, but are monitoring the situation

Band: ATC bands

Several MSS bands may be made available for ATC use:

- *MSS*: 1525–1559/1626.6–1660.6MHz
- *Extended MSS*: 1518–1525/1668–1675MHz
- *S-band*: 1980–2010/2170–2200MHz
- *Big LEO*: 1610–1626.5/2483.5–2500MHz

Saudi Arabia, Brazil, and Australia are all at varying stages in the assignment process of issuing terrestrial rights of use in the S-band. Australia is also planning a review of the use of the extended MSS band. However, in several cases, ATC spectrum is only available for use by satellite operators in conjunction with MSS use (as opposed to being available for MNOs)

The US and Canada already have ATC assignments in certain bands (MSS and Big LEO for Canada, and MSS for the US)

Source: Radio Regulations, NRAs, Analysys Mason

Key: US | Rest of world

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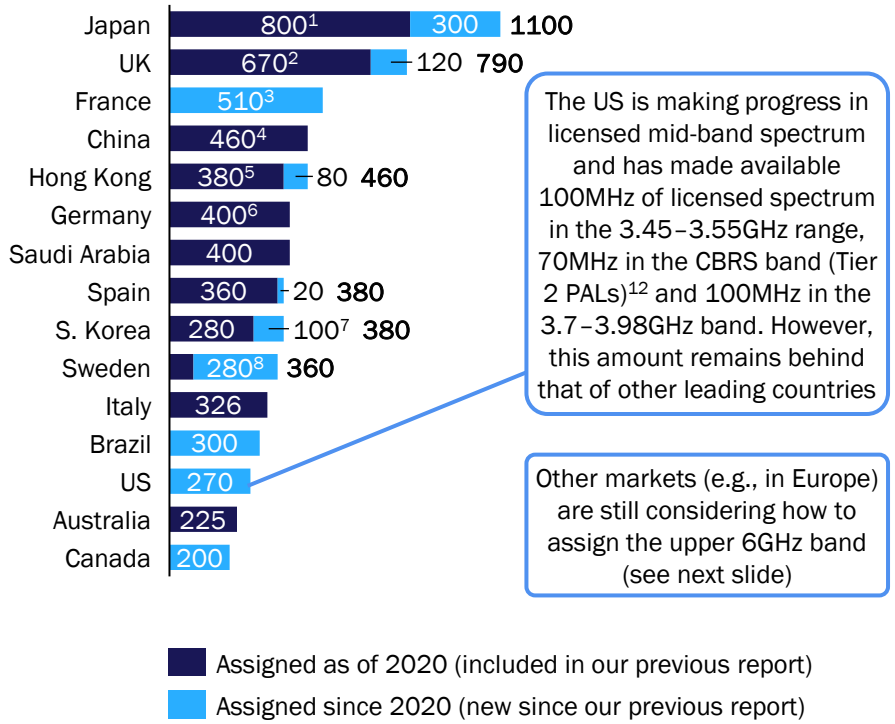
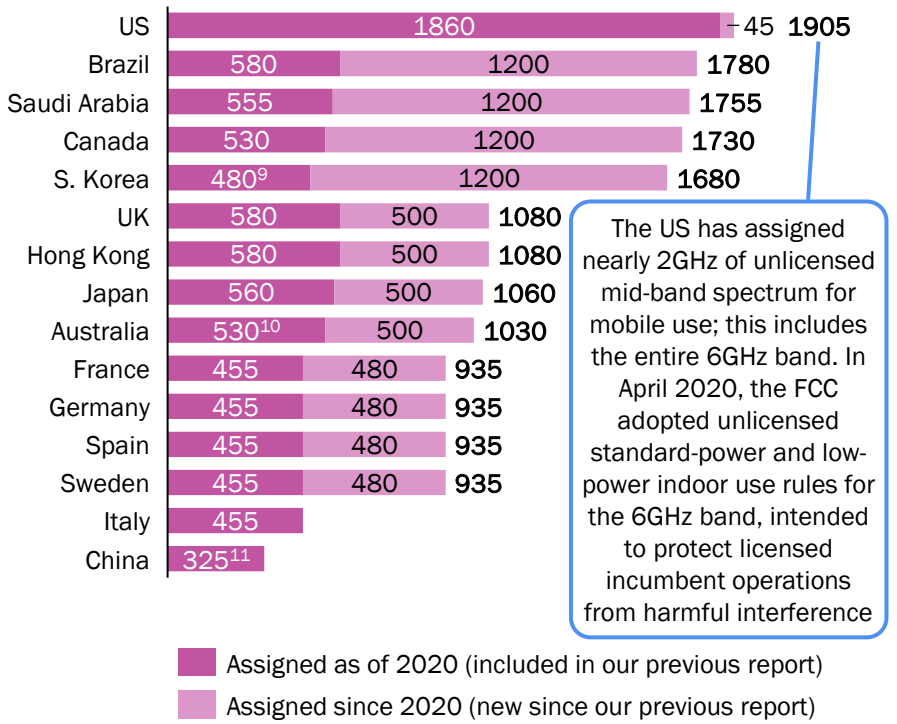
The US currently has more unlicensed mid-band spectrum available for mobile use than any of the other benchmark countries, but lags on licensed spectrum

Licensed mid-band spectrum currently assigned for mobile use (total MHz)



Unlicensed mid-band spectrum currently assigned for mobile use (total MHz)

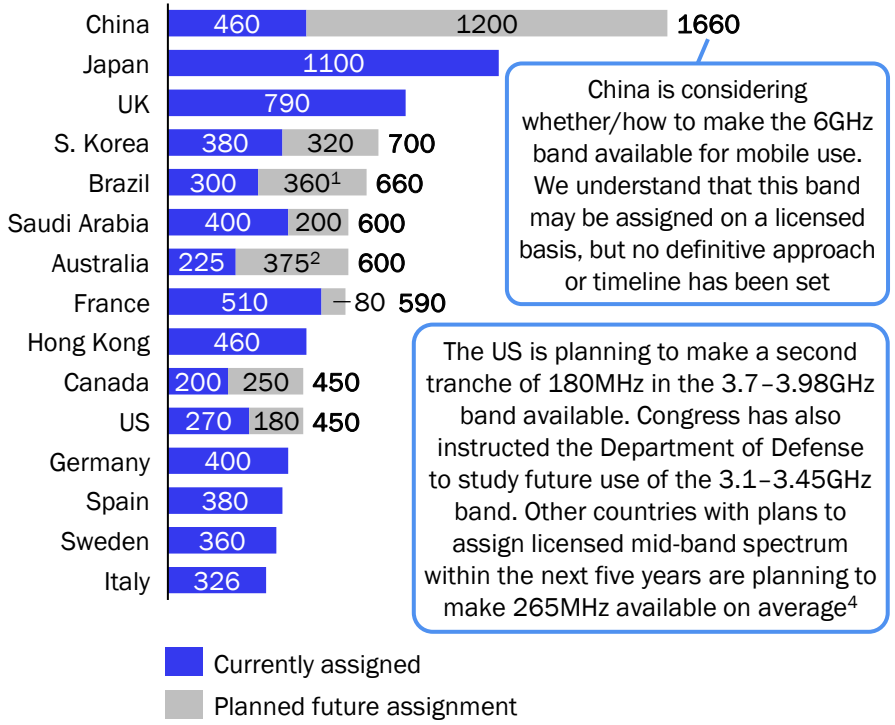


[1] This includes 300MHz (4.6–4.9GHz) for local 5G; [2] This includes 400MHz (3.8–4.2GHz) of 'shared access' spectrum which is available for local licensing; [3] This includes 200MHz (3.8–4GHz) using trial licenses for private use; [4] This includes 100MHz (3.3–3.4GHz) of shared indoor spectrum; [5] 100MHz (3.3–3.4GHz) for indoor use only; [6] 100MHz (3700–3800MHz) is for private local use; [7] 100MHz (4.72–4.82GHz) for private 5G; [8] 40MHz (3.76–3.80MHz) for local permits; [9] This is larger than in our previous report as it encompasses the whole licensed band as opposed to the channels; [10] This includes 100MHz (5.25–5.35GHz) that was not included in our previous report; [11] This is larger than in our previous report as it encompasses the whole licensed band as opposed to the channels; [12] The CBRS band consists of three tiers of use: incumbent (Tier 1), priority access (Tier 2) and general authorized access (GAA) (Tier 3). We have counted the 70MHz of priority access licenses (PALs) as licensed spectrum because it is technically licensed, however it could be excluded altogether and treated as an entirely different category given the lower power limits and government (Tier 1) preemption in place in this experimental system.

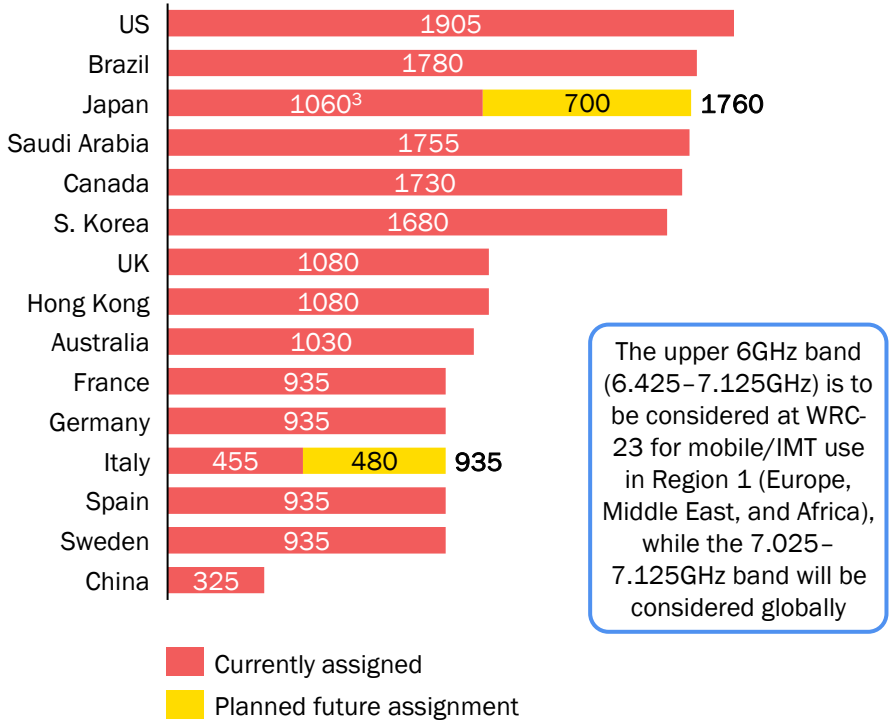
Source: NRAs, Analysys Mason

In five years, the US is expected to continue to lag behind the other benchmark countries in terms of licensed mid-band mobile spectrum

Currently assigned spectrum and planned future assignments of licensed mid-band spectrum suitable for mobile use (total MHz)



Currently assigned spectrum and planned future assignments of unlicensed mid-band spectrum suitable for mobile use (total MHz)



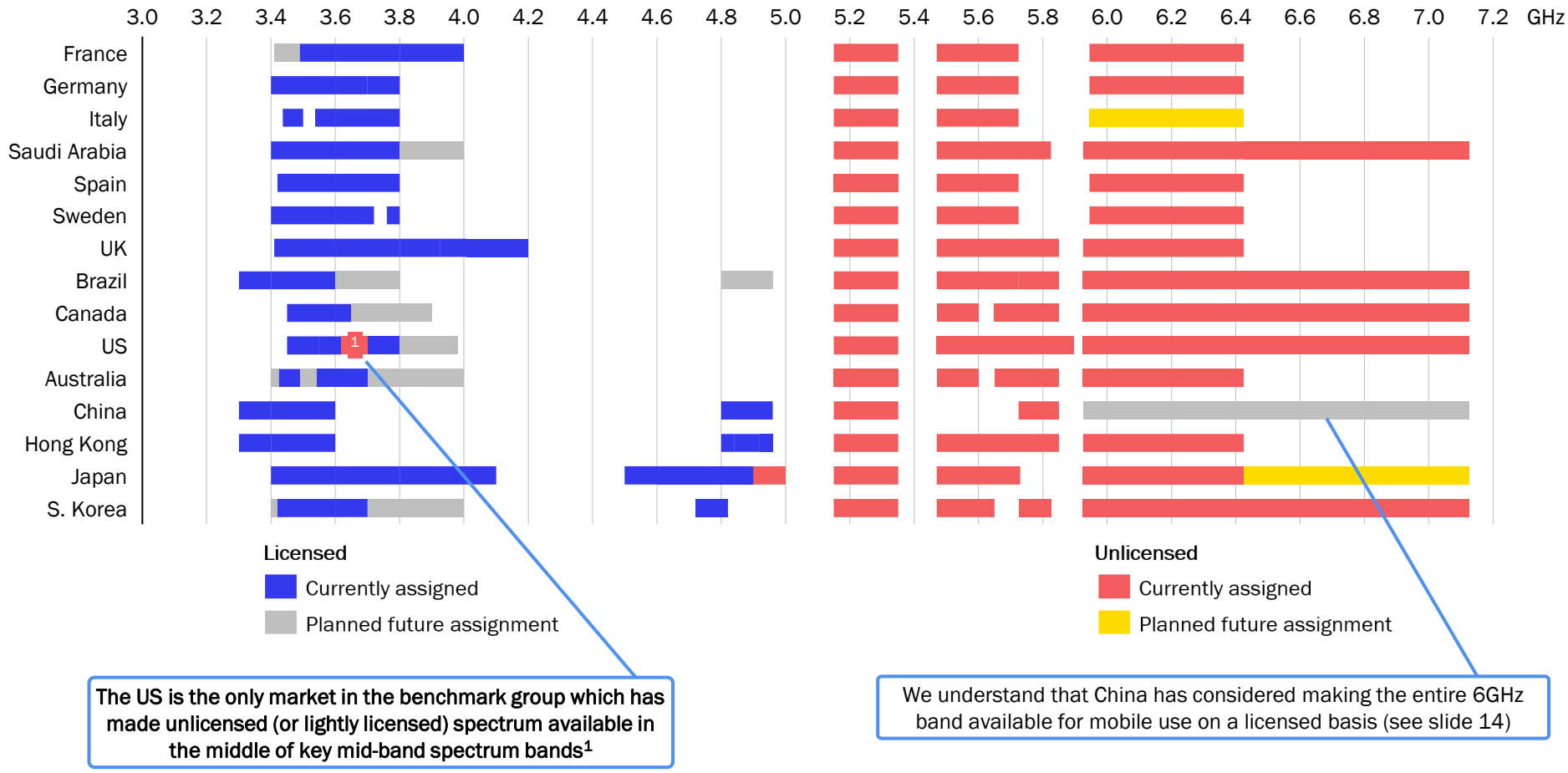
Note: The analysis presented on this slides includes some minor changes compared to our previous report in terms of the classification of guard bands (e.g., 3.8–3.81GHz in Sweden and lower 6GHz in European countries)

[1] 100MHz (3.7–3.8GHz) to be used for private networks; [2] 3.8–4.0GHz is for local area networks; [3] 100MHz (4.9–5GHz) is also being considered as a candidate band for 5G; [4] This average excludes China

Source: NRAs, Analysys Mason

3.4–3.8GHz is the main range for licensed mid-band mobile spectrum, however, this has been expanded to 3.3–4.2GHz (and 4.5–5.0GHz) in several countries

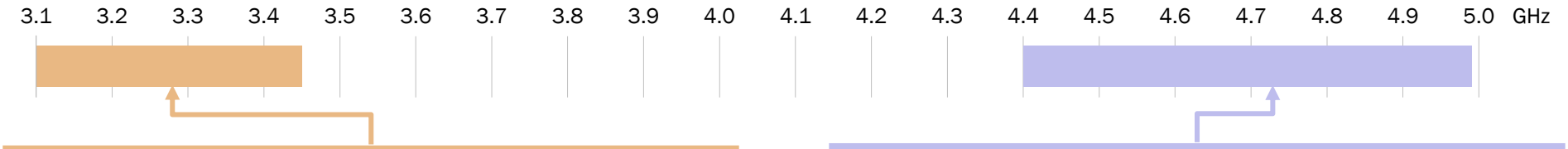
Currently assigned spectrum and planned future assignments of mid-band spectrum suitable for mobile use (band plan)



[1] 70MHz of licensed spectrum in the 3.55–3.65MHz range was auctioned on a regional basis (with the specific frequencies assigned varying by region); the entire CBRS band (3.55–3.7GHz) is available for general authorized access (GAA) (Tier 3) use on an opportunistic (lightly licensed) basis. For the purposes of our analysis, and as noted in the footnote on slide 10, we have counted 70MHz as licensed and 80MHz as unlicensed. Source: NRAs, Analysys Mason

The 4.4–4.99GHz band is of growing interest for mobile use – it has already been assigned or is planned/considered for assignment in several countries

Further mid-band spectrum at the early stages of consideration for mobile/IMT harmonization or allocation



Band: 3.1–3.45GHz

The 3.4–3.8GHz band is currently the main mid band used for 5G globally. There is potential for the bottom of this range to be extended downwards to 3.3GHz, and the 5G 3GPP specifications (bands n77 and n78) already incorporate the 3.3–3.4GHz range

The 3.3–3.4GHz range is currently identified for IMT in select countries in all three regions through footnotes:[1]

- It will be discussed for wider IMT identification in Regions 1 and 2 at WRC-23
- We understand that this is supported by the ATU and AMSG, but not the European Conference of Postal and Telecommunications Administrations (CEPT)
- To date, the 3.1–3.45GHz band has been made available for mobile use in Taiwan, China, Hong Kong, and Brazil

- In the US, Congress has instructed the Department of Defense to study future use of the 3.1–3.45GHz band for IMT/mobile use

Band: 4.4–4.99GHz

The 4.4–4.99MHz band has been allocated for mobile use globally and has been identified for IMT in certain countries. It will be studied for wider mobile/IMT use at WRC-23

Four markets within our benchmark group (South Korea, Japan, Hong Kong and China) have already licensed part, or all, of this band

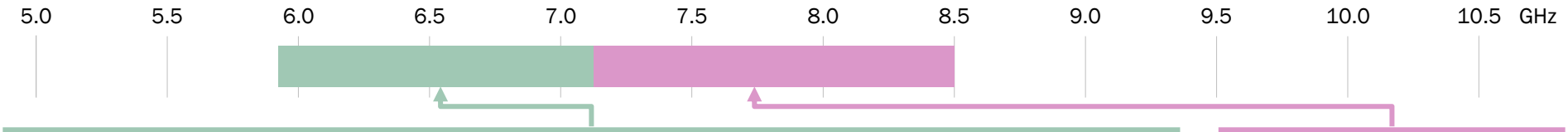
Brazil has plans to release spectrum in this band in the next few years, while other countries (such as Australia and Canada) currently have no plans for this band, but are continuing to monitor it

Key: US | Rest of world

[1] Footnote 5.429B for Region 1 (over 30 African countries), 5.429D for Region 2 (several countries in South America, including Brazil), and 5.429F for Region 3 (seven Asian countries, including India, Indonesia, and Pakistan). Source: Radio Regulations, NRAs, Analysys Mason

The US has made the full 6GHz band available for unlicensed use, and we understand that China has considered making it available for mobile use on a licensed basis

Further mid-band spectrum at the early stages of consideration for mobile/IMT harmonization or allocation



Band: 5.925–7.125GHz

The full 6GHz band (5.925–7.125GHz) is now available on an unlicensed basis in several countries in our benchmark group (Saudi Arabia, Brazil, Canada, the US and South Korea).

In other countries, the lower 6GHz band (5.925–6.425GHz) only is currently available on an unlicensed basis:

- In Europe, the European Commission adopted a decision in June 2021 on harmonization conditions for the use of the 5.945–6.425GHz band on an unlicensed basis. The approach to the upper 6GHz band is still being considered
- Australia allowed the use of radio local area network (RLAN) devices in the lower 6GHz band in March 2022
- Hong Kong released the lower 6GHz band for RLAN use in April 2022
- Japan released the lower 6GHz band for Wi-Fi use in September 2022

In these countries, the upper 6GHz band (6.425–7.125GHz) generally remains under consideration. The upper 6GHz band is to be considered at WRC-23 for mobile/IMT use in Region 1 (with 7.025–7.125GHz to be considered globally). Due to the replanning needed, some regulators do not expect the upper 6GHz band to become available before 2030

China is considering whether/how to use the 6GHz band for mobile, though no definitive approach or timeline has been set. (**We understand that China has considered making the full 6GHz band available for mobile use on a licensed basis.**)

Band: 7.125–8.5GHz

In all regions, the 7.125–8.5GHz band is currently fully allocated for fixed and mobile use; however, other primary allocations are also present in this band

This band is currently unavailable for mobile broadband (and is not on the agenda for WRC-23), but is starting to be investigated for potential assignment in the future for mobile use. We understand that some preliminary feasibility analysis is taking place

At a recent spectrum conference in Europe, Qualcomm stated that it considered this to be a key band for mobile use going forward

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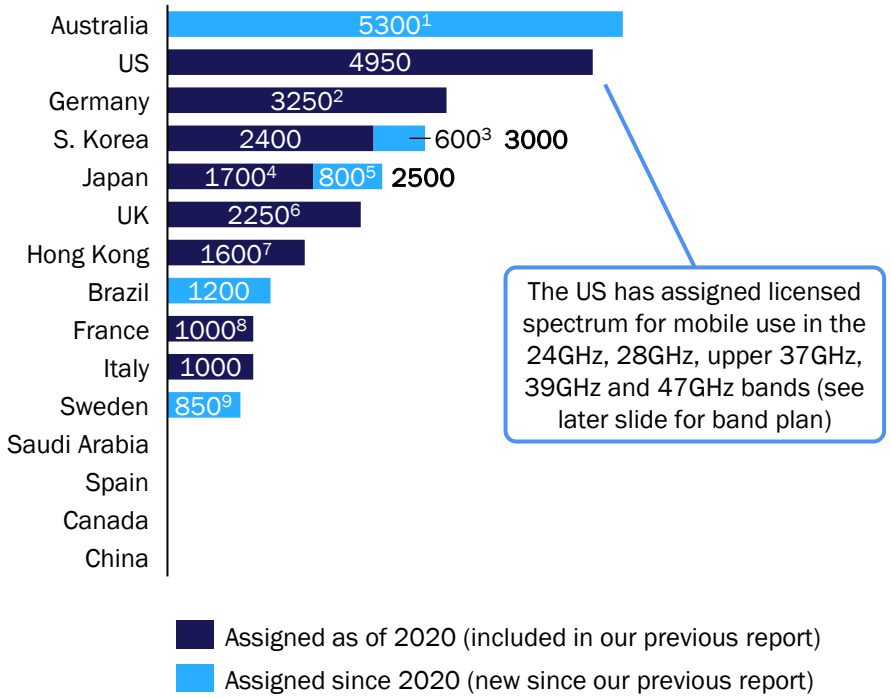
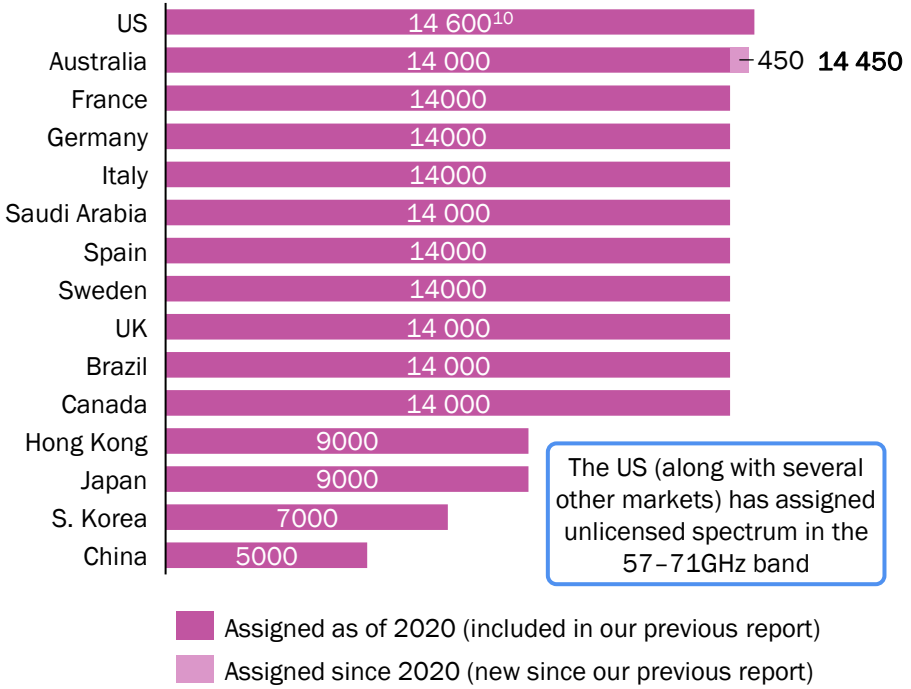
The US is currently a global leader in terms of the amount of both licensed and unlicensed high-band mobile spectrum

Licensed high-band spectrum currently assigned for mobile use (total MHz)



Unlicensed high-band spectrum currently assigned for mobile use (total MHz)



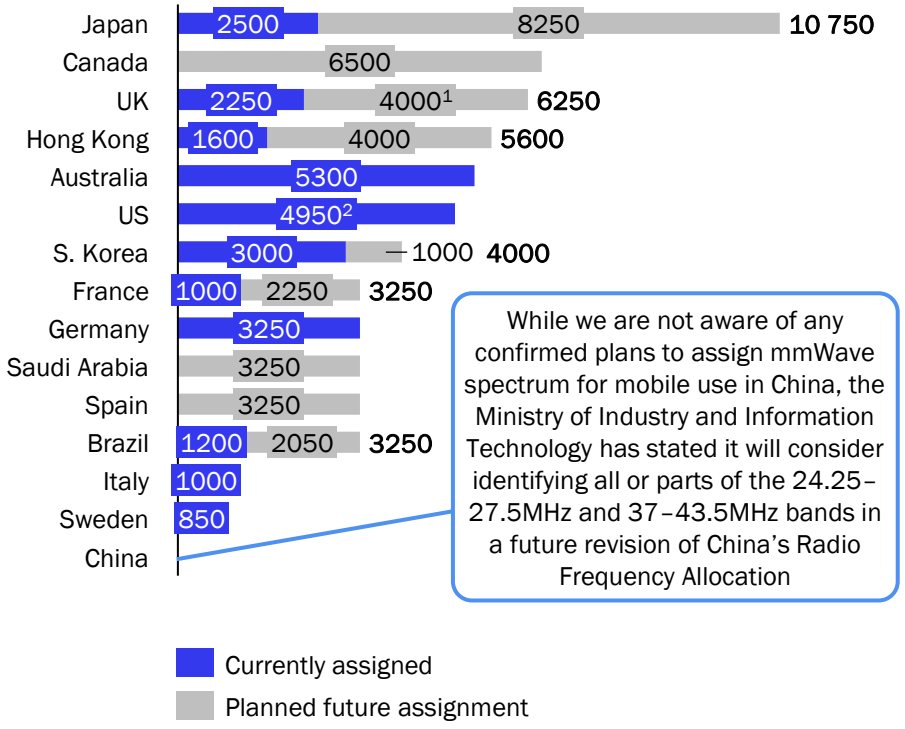
[1] 2900MHz (24.7–25.1GHz and 27.5–30GHz) is for local use; [2] Local licenses; [3] 600MHz (28.9–29.5GHz) is for local licensing; [4] 900MHz (28.2–29.1GHz) is for local use; [5] We have excluded the experimental license awarded to Fujikura in the 66–71GHz band; [6] 'Shared access' spectrum which is available for indoor use only, local licensing; [7] 400MHz (27.95–28.35GHz) is for local licensing; [8] Currently trial licenses for private use; [9] 850MHz (24.25–25.1GHz) is for local licensing, indoor use only until 2025. We have excluded trial licenses (26.5–27.5GHz, 40.5–43.5GHz, 45.5–47GHz, 47.2–48.2GHz, and 66-71GHz), which are available until June 2023; [10] The 37–37.6GHz band is available on a shared coordinated basis

Note: changes were made in the EU/CEPT in 2019 to extend unlicensed use of the 55–66GHz band upwards to 71GHz. This was not correctly captured for European countries (other than the UK) in our previous report and has been corrected in the charts above

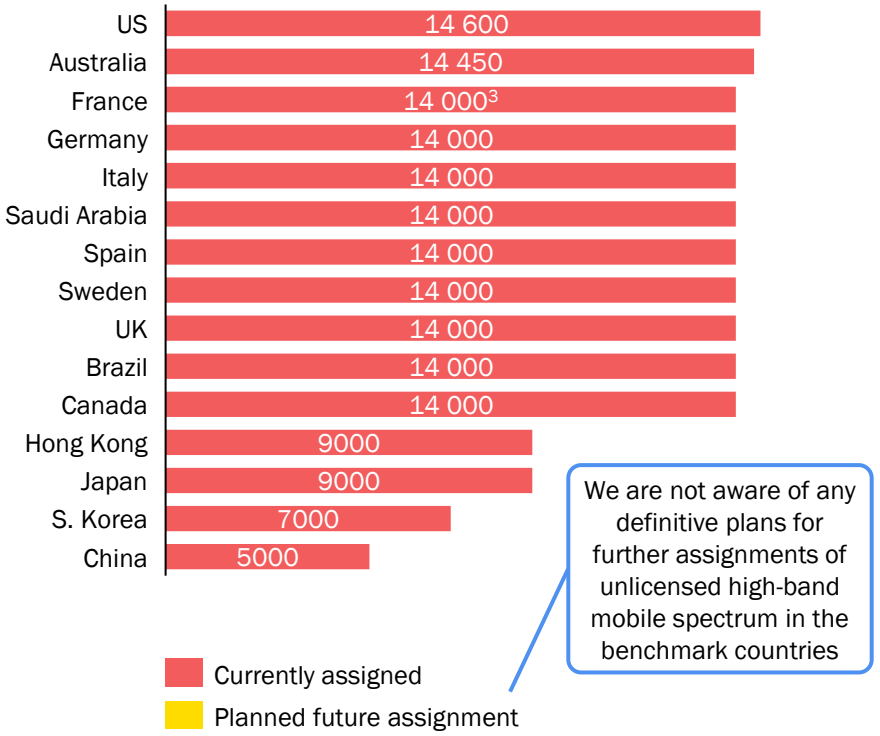
Source: NRAs, Analysys Mason

In five years, five countries are expected to overtake the US in terms of licensed high-band mobile spectrum by an average of 1930MHz

Currently assigned spectrum and planned future assignments of licensed high-band spectrum suitable for mobile use (total MHz)



Currently assigned spectrum and planned future assignments of unlicensed high-band spectrum suitable for mobile use (total MHz)

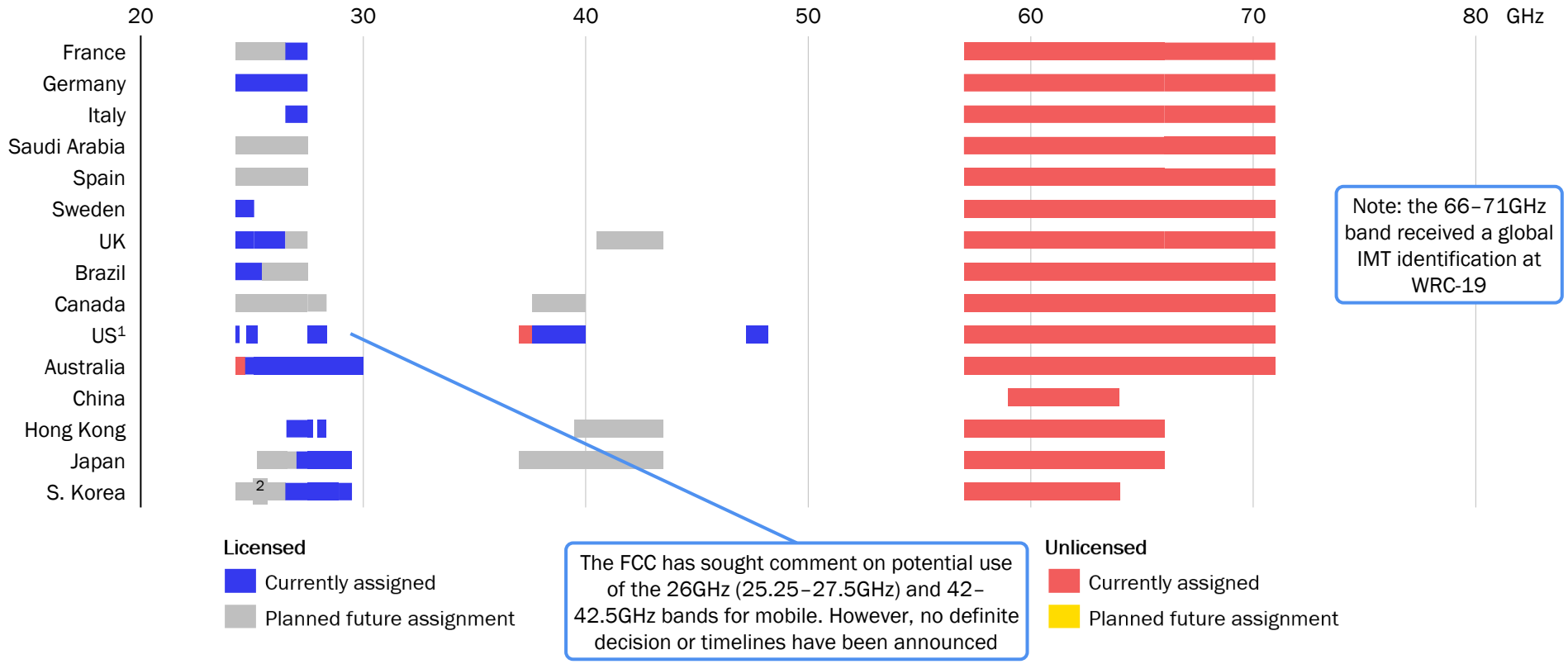


[1] 1GHz (26.5–27.5GHz) is a mix of local, shared-access licenses, and auctioned licenses for cities/towns; [2] The 26GHz (25.25–27.5GHz) and 42–42.5GHz bands were included as future assignments in our previous report. We have now removed these, noting the lack of progress/timeline on the assignment of these bands. We have also excluded the 50.4–52.6GHz band, which the FCC has sought comment on for making it available for flexible terrestrial use; [3] The 66–71GHz band is also being considered as a candidate band for 5G

Source: NRAs, Analysys Mason

26/28GHz is the main high-band range that has been licensed for mobile use to date, although some countries have also licensed higher frequency ranges

Currently assigned spectrum and planned future assignments of high-band spectrum suitable for mobile use (band plan)



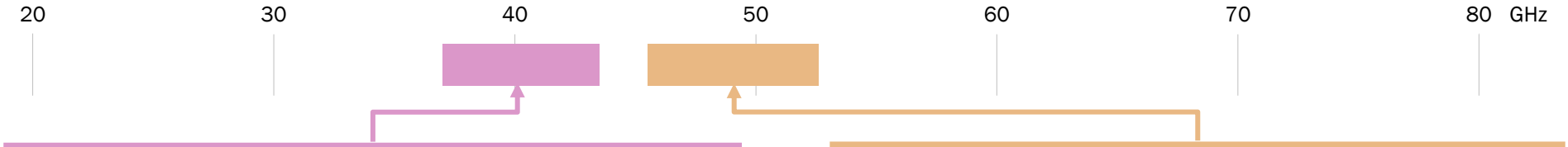
[1] The 26GHz (25.25–27.5GHz) and 42–42.5GHz bands were included as future assignments in our previous report. We have now removed these, noting the lack of progress/timeline on the assignment of this band. We have also excluded the 50.4–52.6GHz band, which the FCC has sought comment on for making it available for flexible terrestrial use

[2] Only 1GHz is planned for assignment

Source: NRAs, Analysys Mason

Several of the WRC-19 mmWave bands are being considered for mobile use in specific countries, and certain NRAs have also indicated interest in sub-THz spectrum

Further high-band spectrum at the early stages of consideration for mobile/IMT harmonization or allocation



Band: 37–43.5GHz

The 37–43.5GHz band was identified for IMT globally at WRC-19 and it has also received 3GPP new radio (NR) support (n259 and n260)

The US has already assigned the 37–40GHz range and Canada has plans to auction the 37.6–40GHz range in 2024; both markets are investigating the remaining frequencies in the full 37–43.5GHz band

Several markets are in the process of consulting on the 37–43.5GHz band, carrying out studies or issuing trial licenses (Hong Kong, Japan, China, Sweden, and the UK). Others have indicated they intend to begin investigations into the band (Germany, Spain, and Brazil), and finally some are monitoring future trends and demand (e.g., France, Australia, and Saudi Arabia)

Band: 45.5–52.6GHz

The 45.5–47GHz band was identified for IMT in a selection of countries across all three ITU regions, and the 47.2–48.2GHz band (which has 3GPP NR support via n262) was identified for IMT in Region 2 as well as in selected countries in Regions 1 and 3. There is potential for IMT identification to be expanded to additional countries in the future

The 47.2–48.2GHz band has so far been assigned in the US only. Japan has indicated that they intend to start studying this band, while Saudi Arabia is monitoring any developments. Brazil has announced that discussions on both bands will take place soon, and other markets (such as Australia) are monitoring developments in both bands but have not announced any further plans

The wider 45.5–50.2GHz and 50.4–52.6GHz bands are also of interest to some markets (e.g., Canada and the US), and Sweden currently has trial licenses in the 45.5–48.2GHz band

Source: Radio Regulations, NRAs, Analysys Mason

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