

Spectrum Navigator, Q1 2021

New insights and trends to watch

May 2021



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This quarterly series leverages the GSMA Intelligence Spectrum Navigator tool to identify key trends and insights.

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Spectrum for 5G

Momentum for 5G auctions continues as Chile kicks off assignments in Latin America

Four countries assigned new 5G spectrum in Q1 2021, with Chile becoming the first country in Latin America to assign spectrum for 5G use through an auction process. Progress in low bands continues with the UK awarding spectrum in the 700 MHz band. This is noteworthy because Europe is lagging in this particular band – more than half of the EU countries missed the EC deadline of assigning spectrum for 5G use in the 700 MHz band by the end of 2020.

mmWave is slowly getting more attention

Chile assigned spectrum in the 26 GHz band, making it the first country in Latin America and the 13th worldwide to award mmWave bands for 5G. Some operators have indicated a lack of immediate interest in mmWave spectrum – for example, Polish and Czech operators expressed no interest in the 26 GHz frequency spectrum before 2022, while in March 2021 Luxembourg became the latest country to adopt this view. However, assignments of mmWave spectrum are growing as 5G rollouts gain momentum and mmWave gets more attention within the wider mobile ecosystem. At least seven more auctions in 2021 will include mmWave spectrum.

Spectrum for legacy networks

Lots of spectrum left in legacy bands

Assignments of spectrum for legacy network generations (2G, 3G and 4G) took place in seven countries in Q1 2021. It is important to note that in six of these countries, spectrum blocks have been released for the first time, with spectrum in some of these bands first being assigned over 25 years ago. For example, the first assignment in the 1800 MHz band in Bangladesh was in 1996, which means that it took 25 years for this spectrum band to be assigned in its entirety. Delays in assignments affect both the timing of network rollouts and quality of service, as operators are required to make use of limited available bandwidth.

2100 MHz continues to be the most refarmed band for 5G

Six out of the 58 new 5G network launches in the previous six months up to Q1 2021 were supported by spectrum in the 2100 MHz band. Because of delays in 'new' spectrum assignments for 5G, operators are refarming existing bands to support deployments. There are currently 18 confirmed 5G networks being supported by spectrum in the 2100 MHz band, making this the most commonly used legacy spectrum band for 5G.

Spectrum pricing

Most expensive spectrum auction ever

The US mid-band spectrum auction that concluded in January 2021 exceeded all price predictions. With \$81 billion spent, it is by far the most expensive spectrum auction in history. While the underlying prices reflect strong appetite for mid-band spectrum in the US, the resulting investment may create short-term constraints for operators as they look to invest in upgrading mobile networks. Some operators have borrowed funds to support this spectrum acquisition. Some are also announcing ambitious deployment targets to secure a quicker return on their investments. On the positive side, this may encourage other governments to accelerate the release of 5G spectrum.

High reserve prices leave valuable spectrum unsold yet again

In the latest Indian spectrum auction some frequencies were either sold at reserve price or not sold at all. A total of 2308.8 MHz was on offer across seven bands, out of which only 855.6 MHz (37%) was sold. All spectrum sold went at reserve price, while the 700 MHz and 2.5 GHz bands did not receive any bids. Lack of appetite for the valuable 700 MHz spectrum was due to high reserve prices; for operators, the priority is to first ensure continuity of spectrum licences coming up for renewal or to consolidate current holdings in bands already assigned.

Spectrum regulation

Novel conditions continue to surprise

Mobile operators in Brazil face onerous spectrum licence conditions for the upcoming auction in Q2 2021. Obligations apply to all spectrum bands on offer (with the exception of the 26 GHz band), for spectrum earmarked for 4G and 5G. For the 3.5 GHz band in particular, obligations include launching standalone 5G in all Brazilian capitals by the middle of 2022, supporting clearing the band, building a separate network for the government, rolling out extensive fibre deployments and providing coverage of all federal highways up to 2025.

Local licensing continues to gather steam

In Q4 2020, Australia and Germany became the newest additions to the growing number of countries making spectrum available through local licences as opposed to on a national level (Japan and Hong Kong are other notable examples). Ireland became the latest country to consider this approach, although this is currently still at a consultation stage. Local licensing is seen as a way to support innovation in the wider mobile industry (as well as vertical industries) and enable new users to access spectrum in key bands through more localised licences.

New assignment models

Less upfront fees in exchange for more stringent obligations

Under a new licensing approach for the upcoming auction in Q2 2021 in Brazil, mobile operators have the option to convert part of the upfront fees determined through the auction process into additional obligations. While the current rules are yet to be approved by Brazil's federal audit court, it is evident that mobile operators in Brazil will be faced with added pressure to comply with a variety of new and potentially extended spectrum licence conditions.

Making the 700 MHz available for 5G through cooperation

The four Polish operators, Exatel and the Polish Development Fund are cooperating on 5G. The aim is to leverage the 700 MHz band to build a nationwide infrastructure (owned by the state via a special-purpose vehicle called Polskie 5G). Poland's Office of Electronic Communications is proposing to assign the entire 700 MHz band (2x30 MHz) to this new entity, with a view to first provide connectivity to public protection and disaster relief services. Reserving spectrum for vertical use is not a new approach; the novelty here is the band and amount. The 700 MHz band is key for providing wide coverage and in-building penetration.

Other spectrum developments

Setting the spectrum roadmap for 6G

Recent 6G announcements have started to focus on use cases and roadmaps. The recently launched ITU-R 6G Vision Group is tasked with defining the technology and its capabilities as the industry moves towards 6G standardisation. Meanwhile, China's government reportedly plans to prioritise the development of 6G to 2025 to make 6G part of its wider digital strategy. In North America, the Next G Alliance has started working groups on the 6G roadmap. From a spectrum angle, 6G is about communicating in GHz and THz bands. It may seem premature to start discussing the next generation of technology while 5G spectrum is yet to be assigned in many countries. However, when it comes to spectrum, discussions have to start early as the process takes time. The key band for 5G (3.5 GHz) was initially discussed at the ITU's World Radiocommunication Conference in 2007, with the first assignment following a decade later.

DSS technology enables smooth migration to 5G

Dynamic spectrum sharing (DSS) allows use of the same spectrum band for different radio access technologies (e.g. 4G and 5G). Twenty operators in 14 countries have deployed DSS. More operators have announced plans to do so, bringing the total to 30. DSS is important, as operators can launch 5G in the absence of 'new' 5G spectrum. It also enables greater coverage by allowing use of legacy bands alongside core 'new' 5G bands.

Five things to watch for: 2021 and beyond

- 1 Spectrum sharing on the rise** – Before the 5G era, there was no significant use of shared spectrum, with exclusive licensing having been the main mechanism so far. However, interest in spectrum sharing is growing as the wider mobile ecosystem explores new network models (including private networks) and use cases. This is likely to continue in 2021 and beyond, since more regulators have to consider spectrum-sharing requirements or conditions as part of their new 5G spectrum assignment models, to cater for vertical needs.
- 2 New momentum for spectrum assignments** – In 2021, a mix of 4G and 5G spectrum bands will be assigned in a range of major markets, giving operators the opportunity to renew existing licences or acquire new spectrum: South Africa will assign long-awaited spectrum for 4G, a major breakthrough considering that assignment plans started in 2011; Canada will have its first 5G auction to assign key spectrum in the 3.5 GHz band; and in Latin America, Brazil and Peru will see their first major 5G spectrum assignments.
- 3 mmWave deployments will increase value of spectrum** – Assignments of spectrum in mmWave bands are likely to gain momentum as 5G rollouts and adoption make progress and the mmWave ecosystem matures. Thirteen countries have already released mmWave spectrum for 5G, which is particularly remarkable given that mmWave spectrum was only internationally allocated to mobile services at the recent World Radiocommunication Conference in November 2019 (WRC-19). Deployments in mmWave spectrum, coupled with device developments, could add value to this spectrum.
- 4 Spectrum refarming will fuel 5G deployments in developing markets** – As developing markets enter the 5G era, spectrum availability will become crucial for operators that wish to deploy 5G networks and launch 5G commercial services. If governments in these countries are slow to act, operators will be required to explore ways of refarming existing spectrum bands to support deployments of new 5G networks.
- 5 Network sunsets will accelerate** – 2021 is expected to be the year with the most 2G and 3G network sunsets ever. The rollout of 5G networks has led operators and regulators to step up plans to switch off legacy networks and refarm 2G and 3G spectrum for 4G and 5G. This will also allow operators to shift frequencies towards more spectral-efficient networks. By reducing the number of technologies maintained, operators should be able to lower running costs significantly, rationalise device portfolios and simplify tariff structures.

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5G spectrum state of play

- Market update** – New spectrum specifically earmarked for 5G has been assigned in 39 countries. Some other countries are in the process of assigning spectrum, bringing the total to 54.

Status	No. of countries (as of 31 March 2021)	Previous quarter (Q1 2021)
Assigned	39	4
Of which assigned and more planned	9	N/A
Planned	15	N/A

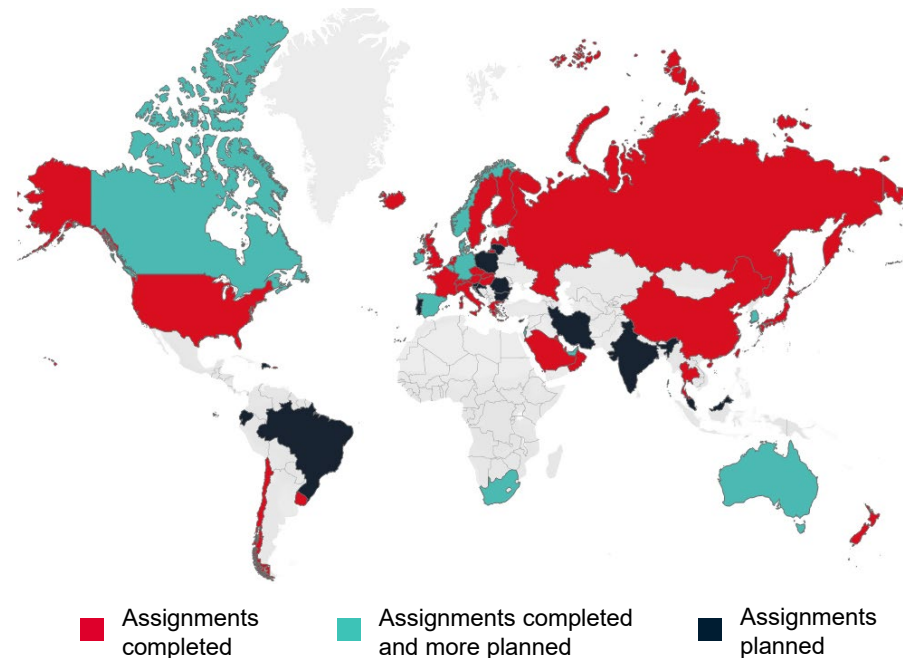
- Operator update** – 133 individual operators have received spectrum for 5G use across three key ranges of frequency bands. This is a 50% increase compared to 2019 despite challenges from Covid-19, a notable achievement.

Frequency range	No. of operators (as of 31 March 2021)*	Previous quarter (Q1 2021)
Low band (<1 GHz)	60**	3
Mid-band (1–6 GHz)	109**	12
High band (>6 GHz)	44**	3

* A range of operators have received spectrum for 5G in multiple bands.

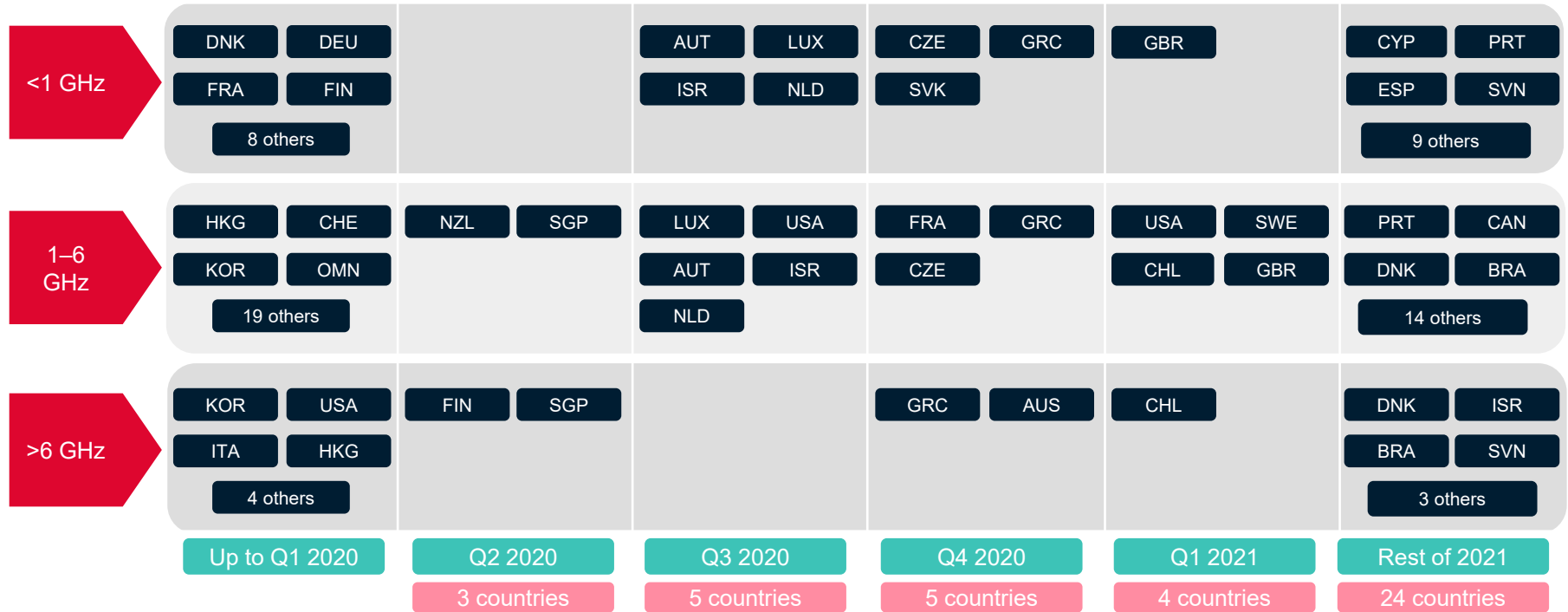
** Excluding US and Canadian regional operators/winners.

5G spectrum assignments



5G spectrum assignments pipeline

- Momentum is building** – After an initial slowdown in Q2 2020 (due to Covid-19 lockdowns), spectrum assignments started to accelerate. In 2021, there will be new spectrum assignments across 28 countries, a significant increase compared to 2020 (17 countries). Other countries may make announcements throughout the year as 5G plans ramp up. Momentum will build, especially in Europe, where more 700 MHz band assignments are expected to take place. Largely confined to a few countries so far, mmWave will also gain traction in 2021 and beyond.



5G spectrum assignments in Q1 2021

- **Assignments continue despite new Covid-19 lockdowns** – Four auctions for 5G spectrum ended in Q1 2021 in four countries. Of these, Chile was the only country to assign 5G spectrum for the first time. The US had its second mid-band spectrum auction, assigning new spectrum to various operators including the three major MNOs. In the UK, Ofcom announced the outcome of the principal bidding stage of its new 5G spectrum auction, releasing the entire 700 MHz band and additional spectrum in mid-band. Chile was the first country in Latin America to conduct a competitive 5G assignment process. Chile is also the 13th country in the world and the first in Latin America to assign spectrum in mmWave bands.

5G spectrum assignments in Q1 2021

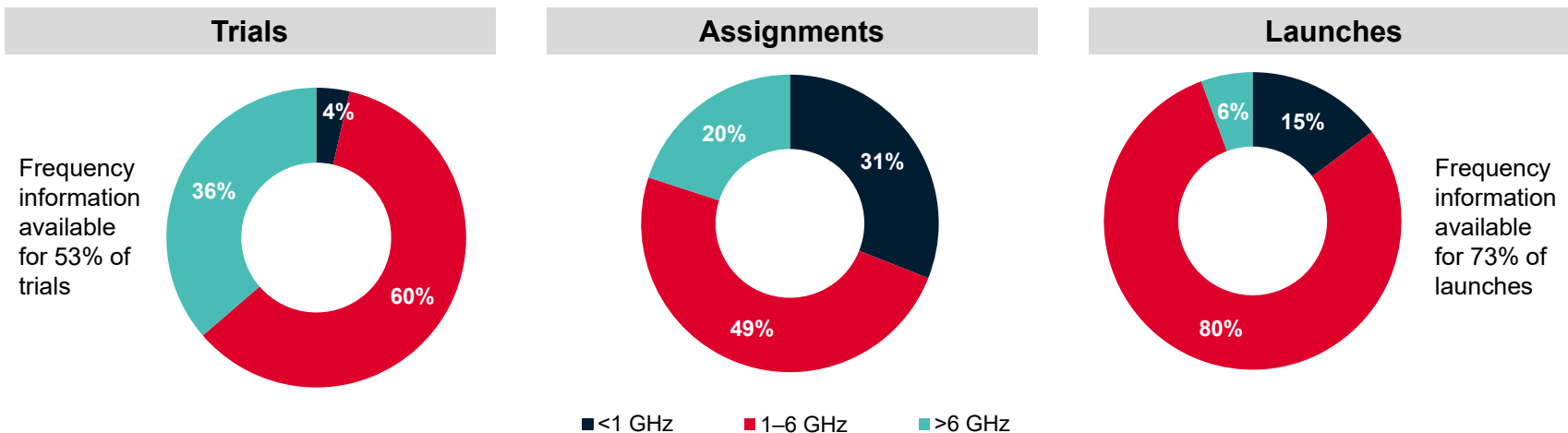
Country	Date	Bands	Bandwidth	Upfront fees	\$/MHz/pop/year (PPP)	Number of winners
US	Jan 2021	3.7 GHz	280 MHz	\$81.1 billion	\$0.069	21 – including Verizon, AT&T and T-Mobile
Sweden	Jan 2021	3.5/3.7 GHz	320 MHz	\$228.4 million	\$0.003	3 – Three (CK Hutchison), Net4Mobility, Telia
Chile	Feb 2021	3.5 GHz	250 MHz	\$346.1 million	\$0.007	4 – Movistar (Telefónica), Claro (America Movil), Entel, WOM (Novator)
		26 GHz	1200 MHz	No upfront fees	N/A	
UK*	Mar 2021	700 MHz	80 MHz	\$1.16 billion	\$0.011	4 – EE (BT), O2 (Telefónica), Three (CK Hutchison), Vodafone
		3.7 GHz	120 MHz	\$706.5 million	\$0.005	

* Results of principal bidding stage

5G spectrum by band range

- **Trials** – 224 individual operators have conducted a total of 592 5G trials. Frequency information is available for 53% of these. The majority of trials have been conducted in mid-band spectrum (1–6 GHz). However, the number of trials in mmWave bands now exceeds 100, which shows the technology is reaching a more mature stage.
- **Assignments** – 133 individual operators across 39 markets have received 5G spectrum. Nearly half of the assignments were for mid-band spectrum (the vast majority in the 3.5 GHz band). However, awards in 700 MHz will gain momentum – at least 13 new assignments are expected in the rest of 2021.
- **Launches** – 159 individual operators have launched commercial 5G networks (mobile and/or FWA). Frequency information is available for 73% of these. 80% of 5G networks have been launched using mid-band spectrum. This comes as no surprise, as 3.5 GHz is the most frequently assigned band and it offers a better balance between coverage and capacity for current 5G use cases and deployment scenarios.

5G spectrum by band range



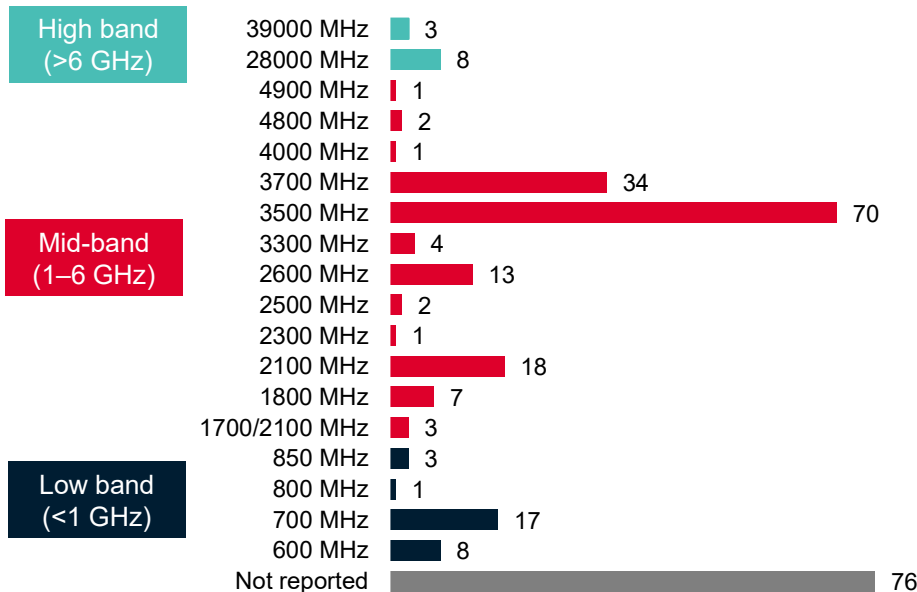
Note: These figures refer to trials, assignments and launches, not to individual operators. A range of operators have trialled or launched their 5G networks on more than one frequency. Totals may not add up due to rounding.

Data correct to 31 March 2021
Source: GSMA Intelligence

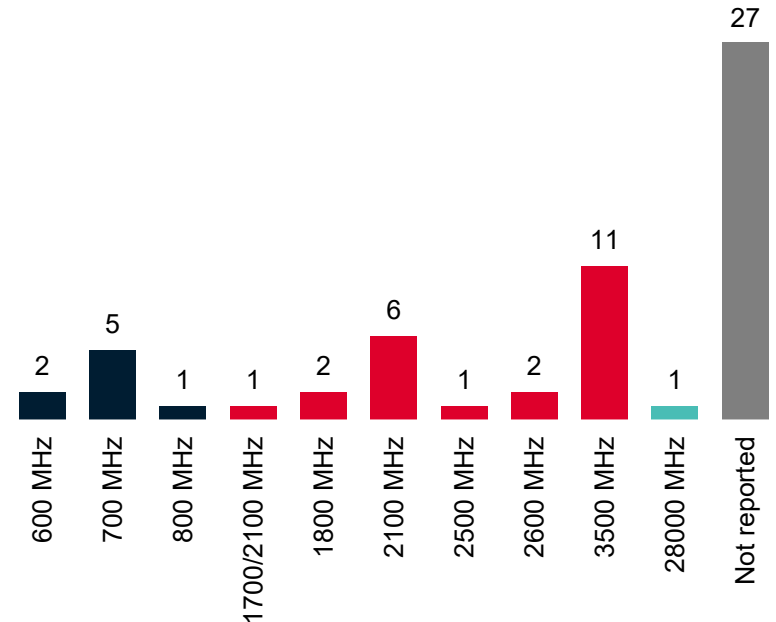
5G network launches by spectrum frequency

- 3.5 GHz remains the main choice** – The 3.5 and 3.7 GHz bands account for 53% of 5G network launches (excluding frequencies not reported). The key coverage band is 700 MHz, which accounts for nearly 60% of the 5G network launches in low-band spectrum. However, as 5G spectrum has yet to be assigned in many markets, a number of operators are refarming existing spectrum bands for 5G deployments. So far, the 2100 MHz band appears to be the most refarmed legacy band, with 18 5G networks currently operating on this frequency.

5G network launches by spectrum frequency (up to Q1 2021)



5G network launches in the previous six months to Q1 2021



Note: These figures refer to trials, assignments and launches, not to individual operators. A range of operators have trialled or launched their 5G networks on more than one frequency.

Source: GSMA Intelligence

DSS technology status

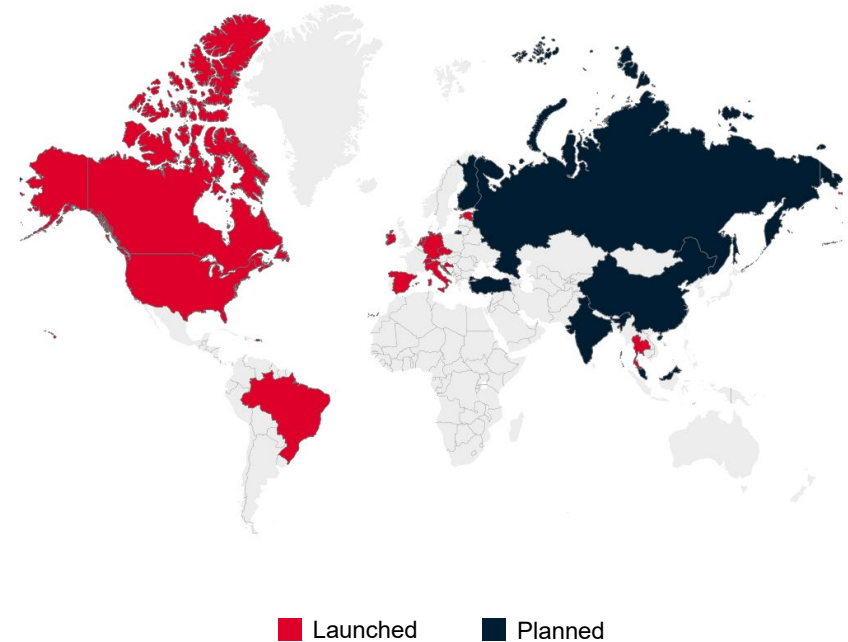
- **Market update** – Dynamic spectrum sharing (DSS) allows mobile operators to use the same spectrum band for different radio access technologies such as 4G and 5G. DSS has been deployed* for 5G networks by 20 operators across 14 countries. Other operators have announced plans to launch 5G services using DSS, bringing the total to 30.

Status	No. of countries (as of 31 March 2021)	No. of operators (as of 31 March 2021)	Previous quarter (Q1 2021)
Launched	14	20	1
Planned	8	10	N/A

- **Operator update** – DSS enables operators to launch 5G in legacy bands** in the absence of ‘new’ 5G spectrum by removing the need for refarming. It also helps operators achieve greater coverage by enabling the use of legacy bands alongside core 5G bands. As of 31 March 2021, seven operators have launched 5G in legacy bands and nine are using a mix of legacy bands and ‘new’ 5G spectrum.

Frequency	No. of operators (as of 31 March 2021)
Legacy bands for 5G use	7
New & legacy bands for 5G use	9
No frequency information	4

DSS deployment status – global overview



■ Launched ■ Planned

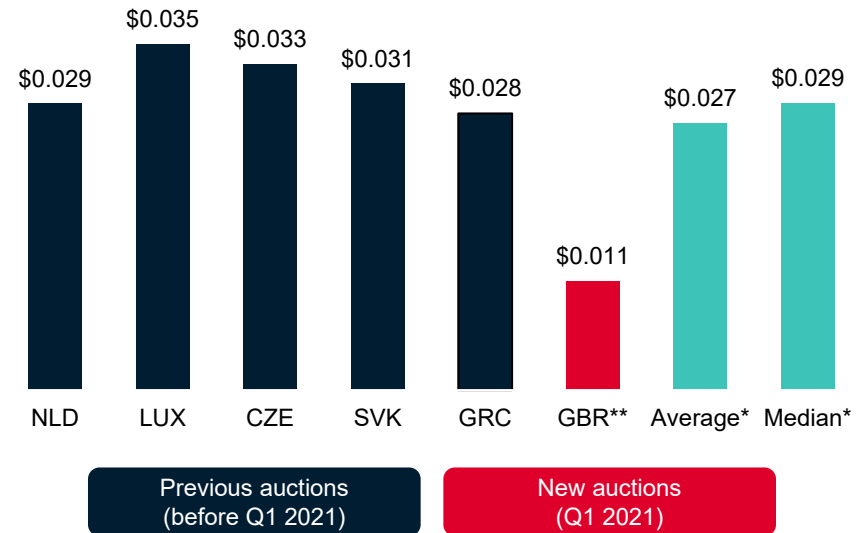
* Based on mobile operator reported data

** Legacy bands refer to spectrum assigned for previous generation networks (2G, 3G and 4G)

5G spectrum pricing: low band (<1 GHz)

- More countries on board** – As of 31 March 2021, a total of 20 countries have assigned spectrum in the 600 and 700 MHz bands, earmarked for 5G. Although Europe as a region is leading the way in assigning 5G spectrum in low bands, progress within the EU-27 states has been slow, with 14 countries having missed the EC award deadline (December 2020).
- Price variations** – Analysis based on all the prices available for low-band 5G spectrum (pricing data is not available for some auctions) shows significant variation in the prices paid. This ranges from as low as \$0.003 (\$/MHz/pop/year (PPP)) in Iceland (2017) to as high as \$0.053 in Canada (2019), with an average of \$0.027.
- Understanding recent trends** – Five of the last six auctions for low-band spectrum had a final price (\$/MHz/pop/year (PPP)) higher than the average price of all 5G spectrum assignments for low band. This was mostly due to high reserve prices. In fact, the final prices paid by winners have been, on average, only 2% higher than the reserve prices, confirming that reserve prices were set at high levels from the beginning. In the recent UK auction, MNOs committed to pay on average \$0.011. Although this is 38% higher than the reserve price, it is far lower than the average price paid for spectrum in this frequency band so far.

5G spectrum pricing for low band (<1 GHz)
\$/MHz/pop/year (PPP)
Selected markets (previous six assignments)



* Average and median of all 5G spectrum assignments for low band (<1 GHz). Calculated based on all prices available.

** Based on results from principal bidding stage.

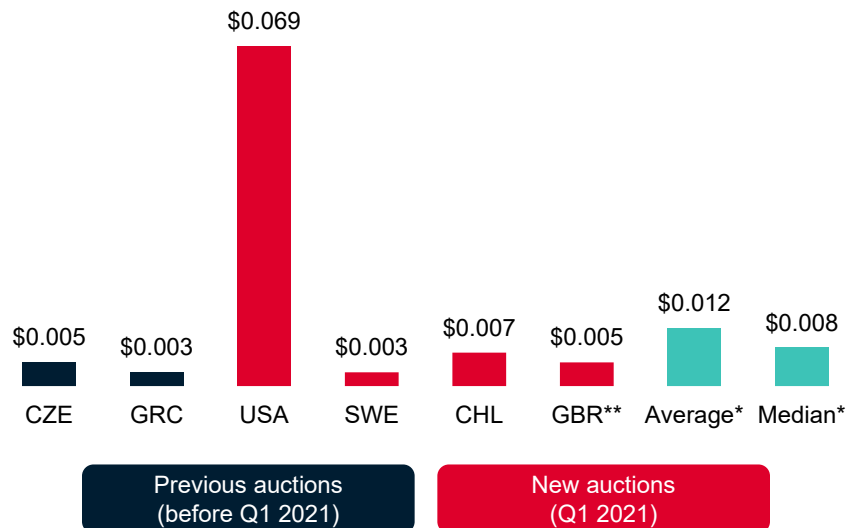
5G spectrum pricing: mid-band (3.5 GHz band)

- **The leading spectrum band range** – Most progress in awarding 5G spectrum has been made in mid-band spectrum. As of 31 March 2021, a total of 32 countries have assigned 5G spectrum in mid-bands.
- **3.5 GHz emerges as key band** – Out of the 39 countries that awarded 5G frequencies, 31 have assigned spectrum in the 3.5 GHz band (which includes the 3.5 and 3.7 GHz bands), making this a critical band for 5G.
- **Price variations** – Variation in the price paid for the 3.5 GHz band is driven by the amount of spectrum made available and auction design. The highest prices (\$/MHz/pop/year (PPP)) paid for spectrum in the 3.5 GHz band have been in Taiwan (\$0.071), Italy (\$0.027) and South Korea (\$0.024). The small amount of spectrum being awarded in Italy and the disparity in lot sizes created artificial scarcity and pressure to win the two wider 80 MHz lots. In Taiwan, only 270 MHz of spectrum has been made available, meaning only two out of five operators could get the largest 100 MHz lots of spectrum.
- **Recent trends** – At \$0.069, the US C-band auction ended up being 3.5× higher than the CBRS auction and 5.5× higher than the average price of all 5G spectrum assignments for the 3.5 GHz band (\$0.012). This price reflects not only the high demand for mid-band spectrum (a function of its potential), but also US-specific market conditions (only 280 MHz of spectrum available during the auction and no more big chunks of mid-band spectrum available in the short term, especially as the 6 GHz band has been now opened for unlicensed use). The results of the recent UK auction principal bidding stage demonstrated a rational bidding approach by MNOs, motivated by existing 5G spectrum that is already available.

5G spectrum pricing for mid-band (3.5 GHz)

\$/MHz/pop/year (PPP)

Selected markets (previous six assignments)



* Average and median of all 5G spectrum assignments for mid-band (3.5 GHz). Calculated based on all prices available.

** Based on results from principal bidding stage.

Source: GSMA Intelligence

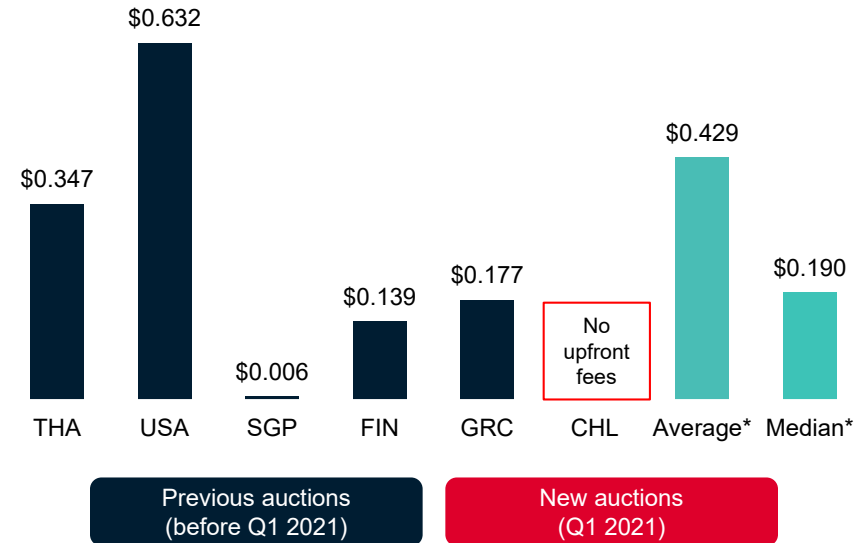
5G spectrum pricing: high band (>6 GHz)

- mmWave lags behind other bands** – In terms of 5G spectrum awards, progress in mmWave has been slower than other bands. As of 31 March 2021, only 13 countries had assigned spectrum in high bands. This is partly because this spectrum has only been allocated for IMT following WRC-19 (November 2019).
- Price variations** – Up to Q1 2021, prices for mmWave spectrum were available for 12 assignments in ten markets. There is significant variation in prices paid for this spectrum. High reserve prices, overall amount of spectrum available and licence conditions are some of the factors that explain the high prices paid. Out of the 12 assignments analysed, the highest prices (\$/GHz/pop/year (PPP)) have been in South Korea in 2018 (\$1.177), the US in 2019 (\$1.008) and Thailand in 2020 (\$0.347). The prices paid in South Korea and Thailand can be explained by high reserve prices: in South Korea, high reserve prices are a historical trend; in Thailand, spectrum was sold at only 6% above the reserve. In the US, at the time of the mmWave auctions, no mid-band spectrum was available, making mmWave the only ‘new’ 5G spectrum on offer. Meanwhile, Singapore offered mmWave spectrum through a beauty contest with only 15% weightage on the offer upfront price, with operators paying the lowest upfront fees (\$0.006). The latest multi-band spectrum assignment in Chile had a zero price tag for spectrum in mmWave bands.

5G spectrum pricing for high band (mmWave)

\$/GHz/pop/year (PPP)

Selected markets (previous six assignments)



* Average and median of all 5G spectrum assignments for high band (>6 GHz). Calculated based on all prices available.

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Spectrum for legacy networks: assignments pipeline

- New assignments** – Assignments in Q1 2021 comprised both ‘new’ spectrum and previously assigned frequencies that came up for renewal. In a bid to increase competition, there has been a growing trend in recent years of regulators re-auctioning spectrum, as opposed to extending licences coming up for renewal. It seems that this trend will continue in 2021. Most of the new licences issued are either 4G or technology neutral, making this spectrum suitable for deployments of any network generation, including 5G.



Note: Split of renewals versus new assignments applies only for historical data.

Spectrum assignments for legacy networks in Q1 2021

- **Momentum continues to build in Q1 2021** – Seven countries assigned spectrum in Q1 2021 across seven spectrum bands. ‘New’ spectrum was assigned in Sweden, Nigeria, Chile, Bangladesh and Kyrgyzstan, while assignments in Hungary and India were for spectrum licences coming up for renewal. Of particular note is the award of spectrum in India, where new frequencies in 700 and 2500 MHz remained unsold due to high reserve prices; for mobile operators, the priority is to first ensure continuity of spectrum licences coming up for renewal or consolidate current holdings in assigned bands.

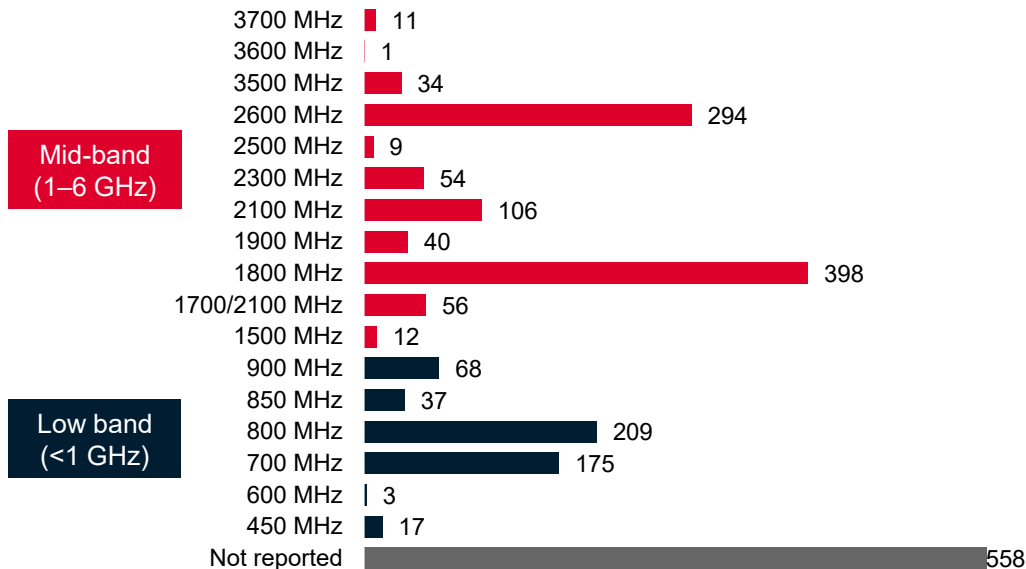
Spectrum assignments for previous network generations in Q1 2021

Country	Date	Bands	Bandwidth	Upfront fees	\$/MHz/pop/year (PPP)	Number of winners
Sweden	Jan 2021	2300 MHz	80 MHz	\$47.7 million	\$0.002	1 – TeraCom
Hungary	Jan 2021	900 MHz 1800 MHz	60 MHz 120 MHz	\$246.3 million \$255.1 million	\$0.060 \$0.031	3 – T-Mobile (Magyar Telekom), Vodafone, Telenor
Nigeria	Jan 2021	900 MHz 1800 MHz	10 MHz 30 MHz	Not available	N/A	1 – Airtel (Bharti Airtel)
Chile	Feb 2021	700 MHz 1700/2100 MHz	20 MHz 30 MHz	\$84.0 million \$22.5 million	\$0.013 \$0.002	1 – WOM (Novator)
India	Mar 2021	800/900/1800/ 2100/2300 MHz	855.6 MHz across 22 circles	\$10.6 billion	N/A	3 – Airtel (Bharti Airtel), Reliance Jio (Reliance Industries), Vodafone Idea
Bangladesh	Mar 2021	1800 MHz 2100 MHz	14.8 MHz 40 MHz	\$229.4 million \$668.8 million	\$0.017 \$0.018	3 – Grameenphone (Telenor), Robi (Axiata), banglalink (VEON)
Nigeria	Mar 2021	800 MHz	20 MHz	Not available	N/A	1 – MTN
Kyrgyzstan	Mar 2021	2300 MHz	60 MHz	\$1.4 million	\$0.001	1 – MegaCom (Alfa Telecom)

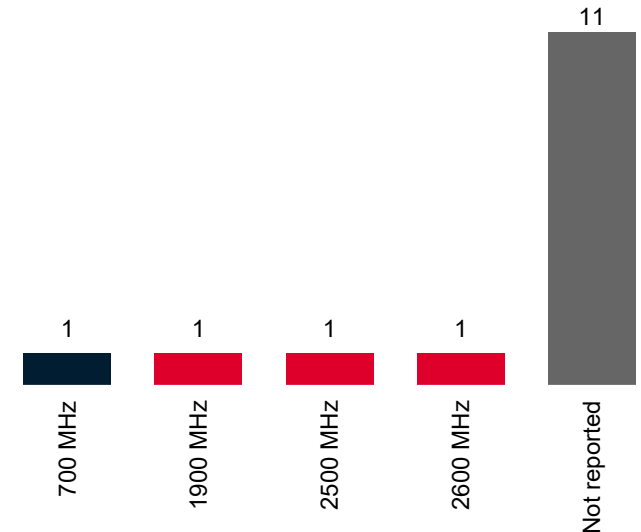
4G network launches by spectrum frequency

- **Don't forget 4G** – A total of 720 individual operators, accounting for 81% of global mobile operators, have launched commercial 4G services (mobile and/or FWA) as of 31 March 2021. The most common spectrum bands used to support 4G network launches are 1800 MHz and 2600 MHz, with nearly half of networks being launched using these bands. The majority of 4G launches in the previous six months to Q1 2021 have been new launches. In addition to this, some operators focused on improving network quality with advanced 4G launches.

4G network launches by spectrum frequency (up to Q1 2021)



4G network launches in previous six months to Q1 2021



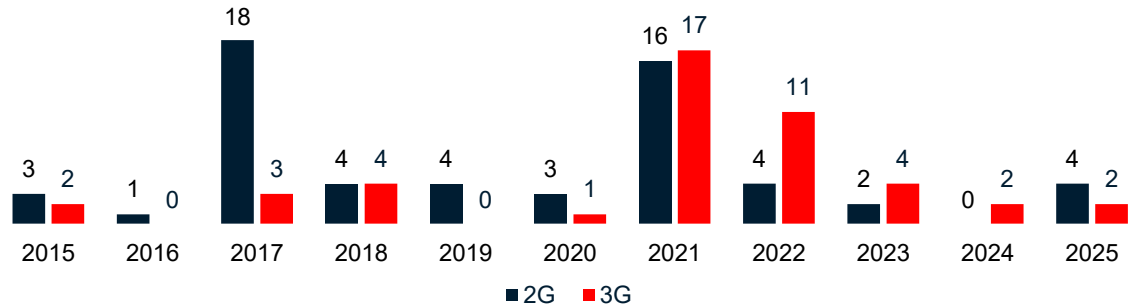
Note: These figures refer to launches, not individual operators. A range of operators have launched their 4G networks on more than one frequency.

Network sunsets

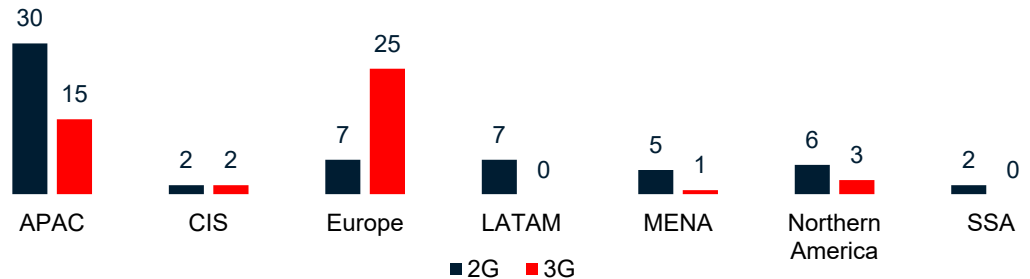
- On the rise** – In the past six years, a total of 43 networks have been shut down, of which 33 were 2G networks and 10 were 3G networks. The pace of shutdowns is likely to accelerate as operators seek to optimise their network operations and costs and refarm the spectrum for 4G and 5G. Based on operators’ announced plans, at least 62 networks will be shut down between 2021 and 2025, of which 26 will be 2G networks and 36 will be 3G networks.

- Regional variations** – The majority of sunsets in Asia Pacific will be 2G networks. Europe is expected to witness 14 network sunsets in 2021 and will have switched off significantly more 3G networks than 2G networks by the end of 2025. 2G services in Europe currently provide for the automotive emergency call service eCall. Taiwan is currently the only market where all operators have shut down both their 2G and 3G networks.

2G and 3G network sunsets (2015–2025)



Split by region – completed and planned sunsets (2015–2025)



Note: Count of generation shutdowns as opposed to technology migration within the same generation of technologies. WiMAX network sunsets not included. Data for 2021–2025 estimated based on operators’ announced plans for shutdowns.

- **Spectrum refarming is widespread** – In the last six months, a range of operators shared updates on their spectrum refarming plans. The 2100 MHz band had the most transitions, with nine operators across five countries refarming spectrum for either 4G or 5G networks. The refarming activity of spectrum used for legacy networks (3G or 4G) for 5G is driven by two factors: the absence of 5G mid-band assignments (e.g. in Denmark and Slovakia) and the need for additional capacity (e.g. in Hong Kong and Germany).

Spectrum refarming announcements (in the previous six months to Q1 2021)

Operator	Country	Frequency	Previous technology	Current technology	Status
TIM (Telecom Italia)	Brazil	2100 MHz	3G	4G	In progress
Three (CK Hutchison)	Denmark	700/1800 MHz	4G	5G	In progress
Vodafone	Germany	2100 MHz	3G	4G	In progress
Telekom (Deutsche Telekom)	Germany	2100 MHz	3G	4G/5G	In progress
O2 (Telefónica)	Germany	900/2100 MHz	3G	5G	Planned
Three (CK Hutchison)	Hong Kong, SAR China	2100 MHz	3G	5G	In progress
Vi	India	2100 MHz	3G	4G	In progress
Airtel (Bharti Airtel)	India	900/2100 MHz	2G/3G	4G	In progress
Tele2 (Rostelecom)	Russian Federation	1800 MHz	2G/3G	4G	In progress
O2 (PPF)	Slovakia	2100 MHz	3G	4G/5G	Planned
Orange	Slovakia	2100 MHz	3G	4G/5G	Planned
Slovak Telekom (Deutsche Telekom)	Slovakia	2100 MHz	3G	4G/5G	Planned
Kyivstar (VEON)	Ukraine	900 MHz	2G/3G	4G	In progress
lifecell (Turkcell)	Ukraine	900 MHz	2G/3G	4G	In progress
Vodafone (NEQSOL)	Ukraine	900 MHz	2G/3G	4G	In progress

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Summary

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Spectrum for 5G

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Spectrum for previous generation networks

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Spectrum navigator: all the data at your fingertips

Our spectrum data

- Ongoing tracking of operators' spectrum assignments, licence duration and obligations
- Granular data covering 200 countries and 1,120 operators worldwide, from 1980 to today, updated regularly
- Basis for understanding future spectrum availability and plans
- Supports device pricing strategies (when combined with our device database)
- Helps identify market trends and opportunities driven by 5G

Spectrum Navigator

- User-friendly and comprehensive spectrum dashboard
- Custom search for spectrum assigned by frequency band
- Granular split by region, country and operator
- Dedicated section on current and future auctioning plans, including disruptions to auctions in times of Covid-19
- Data tables that allow quick understanding of key market questions on licence duration and obligations

How do I get access?

Talk to our Analyst

We would be keen to understand how our spectrum tool and data address your needs and requirements: schedule a demo with our industry expert to find out more. Please email info@gsmainelligence.com for more information.

Talk to your Account Manager

The Spectrum Navigator tool is available as an addition to your GSMA Intelligence subscription. Please email info@gsmainelligence.com for more information.

- [Spectrum for Mobile, Q1 2021: Auctions, mmWave and sharing gain momentum](#)
- [The economics of mmWave 5G](#)
- [5G and economic growth: an assessment of GDP impacts in Canada](#)
- [How spectrum will shape the outlook for 5G in Russia](#)
- [Effective Spectrum Pricing in Africa](#)
- [The Impacts of mmWave 5G in India](#)
- [The impact of spectrum prices on consumers](#)
- [Is 2020 the year for mmWave?](#)
- [US 5G market gets an infusion of mid-band spectrum](#)

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