Spectrum policy

Personal Data

Commercial interests
Outline

- 5G deployment status globally
- Mid-bands spectrum needs for evolution of 5G
- Industrial uses and spectrum
- Spectrum sharing
Global 5G development is gearing up

130+ MNOs in 40+ countries have launched 5G
- Operator(s) that have deployed 5G, services launched
- Operator(s) that have deployed/are deploying 5G, but precommercial
- Other operators investing in 5G

3.5/T2.6/2.3 GHz have become 5G primary bands

- Released
- Plan for release

Source: GSA & Statista 2020 Report
Status in China

**Base stations deployed**

<table>
<thead>
<tr>
<th>Year</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019-12</td>
<td>13</td>
</tr>
<tr>
<td>2020-03</td>
<td>19.8</td>
</tr>
<tr>
<td>2020-06</td>
<td>41</td>
</tr>
<tr>
<td>2020-09</td>
<td>69</td>
</tr>
<tr>
<td>2020-12</td>
<td>&gt;71.8</td>
</tr>
</tbody>
</table>

Unit: 10K

Source: MIIT, Ministry of Industry and Information Technology

- 330K co-construction and sharing sites.
- 718K 5G sites in China by the end of 2020.

**5G subscribers in 2020**

<table>
<thead>
<tr>
<th>Month</th>
<th>CMCC</th>
<th>CTCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6.74</td>
<td>31.72</td>
</tr>
<tr>
<td>2</td>
<td>15.40</td>
<td>31.72</td>
</tr>
<tr>
<td>3</td>
<td>35.10</td>
<td>31.72</td>
</tr>
<tr>
<td>4</td>
<td>43.75</td>
<td>20.05</td>
</tr>
<tr>
<td>5</td>
<td>55.61</td>
<td>57.16</td>
</tr>
<tr>
<td>6</td>
<td>70.20</td>
<td>57.16</td>
</tr>
<tr>
<td>7</td>
<td>84.06</td>
<td>57.16</td>
</tr>
<tr>
<td>8</td>
<td>98.16</td>
<td>57.16</td>
</tr>
<tr>
<td>9</td>
<td>133.59</td>
<td>57.16</td>
</tr>
<tr>
<td>10</td>
<td>128.79</td>
<td>57.16</td>
</tr>
<tr>
<td>11</td>
<td>147.38</td>
<td>72.86</td>
</tr>
<tr>
<td>12</td>
<td>165.00</td>
<td>79.48</td>
</tr>
</tbody>
</table>

Unit: Millions

Source: Monthly Operation Data of CMCC & CTCC

- > 251 Million customers had subscribed to 5G tariff plans by the end of 2020.
Status in China

5G terminals are becoming the mainstream, with price drop driving penetration.

- 163m @ 52.9% 5G mobile phones shipped in 2020.
- Total 5G shipment reached 176m (including 2019).

In 2021, 60% of 5G phones will cost less than $400.

5G smartphone shipment forecast by price

< $150 5G smartphone on sale in China
5G E2E ecosystem at 2.3 GHz is ready for commercial from 2020

5G terminal availability at 2.3 GHz is growing

More 5G networks will be deployed at 2.3 GHz

~2019 2 Countries 2020 3 Countries 2021~ 17 Countries

Global 2.3 GHz band 5G commercial status

<table>
<thead>
<tr>
<th>Region</th>
<th>MNO</th>
<th>Test</th>
<th>Commercial</th>
<th><a href="mailto:BW@2.3GHz">BW@2.3GHz</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>ME</td>
<td>KSA STC</td>
<td>20H2</td>
<td>21~</td>
<td>100M</td>
</tr>
<tr>
<td>Africa</td>
<td>SA Telkom</td>
<td>20H2</td>
<td>21~</td>
<td>60M</td>
</tr>
<tr>
<td>APAC</td>
<td>Australia Optus</td>
<td>19H2</td>
<td>20H1~</td>
<td>50M</td>
</tr>
<tr>
<td>APAC</td>
<td>Thailand DTAG</td>
<td>20H2</td>
<td>21~</td>
<td>80M</td>
</tr>
<tr>
<td>APAC</td>
<td>Indonesia TSEL</td>
<td>20H2</td>
<td>21H1</td>
<td>60M</td>
</tr>
<tr>
<td>APAC</td>
<td>Sri Lanka Dialog</td>
<td>20H2</td>
<td>21~ 22</td>
<td>60M</td>
</tr>
<tr>
<td>APAC</td>
<td>Hong Kong H3G</td>
<td>20H2</td>
<td>21H1</td>
<td>30M</td>
</tr>
<tr>
<td>APAC</td>
<td>Myanmar TPG</td>
<td>21H1</td>
<td>21~ 22</td>
<td>50~100M</td>
</tr>
<tr>
<td>APAC</td>
<td>Vietnam MoHtrJonVNPT</td>
<td>21H1</td>
<td>21~ 22</td>
<td>40~90M</td>
</tr>
<tr>
<td>Europe</td>
<td>Russia RUSO</td>
<td>21~</td>
<td>22</td>
<td>100M</td>
</tr>
<tr>
<td>Europe</td>
<td>Sweden I3G</td>
<td>21H1</td>
<td>22</td>
<td>100M</td>
</tr>
<tr>
<td>LATAM</td>
<td>Peru Entel</td>
<td>21H1</td>
<td>22</td>
<td>60M</td>
</tr>
<tr>
<td>LATAM</td>
<td>Brazil TIM</td>
<td>21H1</td>
<td>22</td>
<td>60M</td>
</tr>
</tbody>
</table>
Commercial Interest
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5G spectrum for capacity, coverage, and user experience

IMT-2020 key capabilities

Main scenarios

Area traffic capacity of 10 Mbit/s/m²

User experienced data rate of 100 Mbit/s

Citywide urban/suburban high capacity coverage including outdoor to indoor

Mid- and high-bands are complementary (i.e., not substitutes): addressing different scenarios, exploiting different IMT-2020 capabilities.

Mid- and high-band spectrum needs should be assessed separately.

High- and mid-bands Ultra experience layer

Mid-bands Capacity/coverage layer

Mid- and low-bands Basic coverage layer

Dense urban | Urban | Suburban | Rural

1. High bands are being used for FWA in some markets.
2. Hotspot and FWA.
Mid-bands: high capacity citywide (urban/suburban) coverage

Important to assess the needs of the city of the future (beyond hotspot requirements) in the 2025-2030 time frame. The spectrum needs of a mobile communication network are the sum of the spectrum needs of each individual use case supported at any given place and time.
Commercial Interest

Webinar: 6 GHz for Europe – January 2021

IMT spectrum demand
Additional mid-band spectrum needed for mobile operators in 2025-2030 timeframe

A total of around 2-3 GHz of mid-band spectrum would enable mobile operators to deliver the ITU-R IMT-2020 requirements in cities in an economically feasible manner.

https://www.gsma.com/gsmaeurope/resources/imt-spectrum-demand/
6 GHz identification at WRC-23 is essential for 5G development in next 10 years

A new agenda item for study of IMT at 6 GHz was set up at WRC-19

Major industry partners have declared 6 GHz as a priority for future IMT spectrum

- Set 6425-7125 MHz as a high priority item for WRC-23 (2020)
- Started 6 GHz NR standardization (2020)
- Statement of support for 6 GHz IMT: Co-signed by 23 partners (2020)
6 GHz expected to be commercially available E2E from 2025

- **2020**: Study of IMT coexistence with incumbents (model/parameters)
- **2021**: 6 GHz NR standardization (band/key technologies)
- **2022**: Field tests in China, Russia (performance + coexistence)
- **2023**: 6 GHz IMT E2E ecosystem establishment
- **2024**: 6 GHz IMT identification at WRC-23
- **2025**: 6 GHz standard in at 3GPP (R18)

**Target population coverage:**
Europe + RCC + Africa + ME + China > 3.6 billion, 52% total population
Recommendations (1)

- An additional 1000 to 2000 MHz of mid-bands spectrum will be required to meet the IMT-2020 user experienced data rates of 100 Mbit/s on the downlink and 50 Mbit/s on the uplink, defined by the ITU-R, for citywide high capacity coverage in the 2025-2030 timeframe.

- The use of such additional mid-bands spectrum for FWA would reduce by €42 billion the cost of achieving European Union’s 2025 connectivity target of 100 Mbit/s broadband for all households.

Exhibit 15: Additional mid-bands spectrum needs (MHz) to meet DL and UL requirement

<table>
<thead>
<tr>
<th>City</th>
<th>Activity factor 10%</th>
<th>Activity factor 15%</th>
<th>Activity factor 20%</th>
<th>Activity factor 25%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High bands</td>
<td>High bands</td>
<td>High bands</td>
<td>High bands</td>
</tr>
<tr>
<td></td>
<td>30%</td>
<td>20%</td>
<td>10%</td>
<td>5%</td>
</tr>
<tr>
<td>Paris</td>
<td>820</td>
<td>1100</td>
<td>1580</td>
<td>2150</td>
</tr>
<tr>
<td>Lyon</td>
<td>170</td>
<td>250</td>
<td>360</td>
<td>490</td>
</tr>
<tr>
<td>Marseille</td>
<td>10</td>
<td>40</td>
<td>100</td>
<td>500</td>
</tr>
<tr>
<td>Berlin</td>
<td>220</td>
<td>300</td>
<td>400</td>
<td>500</td>
</tr>
<tr>
<td>Hamburg</td>
<td>160</td>
<td>250</td>
<td>410</td>
<td>560</td>
</tr>
<tr>
<td>Munich</td>
<td>160</td>
<td>250</td>
<td>410</td>
<td>560</td>
</tr>
<tr>
<td>Rome</td>
<td>150</td>
<td>250</td>
<td>400</td>
<td>500</td>
</tr>
<tr>
<td>Milan</td>
<td>150</td>
<td>250</td>
<td>400</td>
<td>500</td>
</tr>
<tr>
<td>Madrid</td>
<td>160</td>
<td>250</td>
<td>410</td>
<td>560</td>
</tr>
<tr>
<td>Barcelona</td>
<td>400</td>
<td>600</td>
<td>900</td>
<td>1200</td>
</tr>
<tr>
<td>Amsterdam</td>
<td>30</td>
<td>80</td>
<td>150</td>
<td>230</td>
</tr>
</tbody>
</table>

Spectrum need | ≤ 10 MHz | 10 - 500 MHz | 500 - 1000 MHz | 1000-2000 MHz | > 2000 MHz

Source: Coleago, "IMT spectrum demand: Estimating the mid-bands spectrum needs in the 2025-2030 timeframe," December 2020
Recommendations (2)

RSPG draft opinion on spectrum needs:
"recognises the current demand in the majority of MS for additional spectrum is mainly for the mid-bands"

RSPG draft opinion on RSPP:
"...the need for clear spectrum policy direction is as valid as ever."
"RSPG confirms the need for inclusion of policy objectives supporting the development of innovative wireless services based on generic description rather than quantitative."
"In addition, as has been done recently for 5G, the RSPG can develop long-term spectrum availability plans including needs for harmonisation initiatives for key EU policy areas upon request."

- The previous RSPP (2012) did identify quantitative and ambitious targets that represented a clear guidance for industry and administrations ("identify at least 1200 MHz of suitable spectrum by 2015").

- The new RSPP should equally be ambitious in defining quantitative targets for the mid-bands spectrum to be identified in the 2025-2030 time frame, or should at least define clear next steps that will lead to the definition of such targets in the near future.

- Such clarity in the policy direction will be key for operators to define their longer term network and business strategies.
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5G 2B projects in Europe

- We are tracking 453 5G 2B projects (January 2021) in Europe based on public announcements.

Source – Huawei based on public information
5G 2B projects in Germany at 3700-3800 MHz (1/2)

- 106 local 5G network applications, with 102 granted by BNetzA (as of January 2021).
- The spectrum assignments can be for direct service provision, related to specific clients, or for internal R&D, or a combination of these.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total applications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Applications approved</td>
<td>43</td>
<td>74</td>
<td>82</td>
<td>88</td>
<td>97</td>
<td>102</td>
<td>108</td>
</tr>
<tr>
<td>Applicants made public</td>
<td>38</td>
<td>47</td>
<td>51</td>
<td>56</td>
<td>59</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>ICT/telecom</td>
<td>47%</td>
<td>49%</td>
<td>49%</td>
<td>45%</td>
<td>44%</td>
<td>44%</td>
<td></td>
</tr>
<tr>
<td>Verticals</td>
<td>35%</td>
<td>32%</td>
<td>31%</td>
<td>34%</td>
<td>34%</td>
<td>34%</td>
<td></td>
</tr>
<tr>
<td>Research</td>
<td>18%</td>
<td>19%</td>
<td>20%</td>
<td>21%</td>
<td>22%</td>
<td>22%</td>
<td></td>
</tr>
</tbody>
</table>

Source – Huawei based on public information
5G 2B projects in Germany at 3700-3800 MHz (2/2)

3.7-3.8 GHz local licences available since 2019.11

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>First year</th>
<th>2nd year</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDF 90 MHz</td>
<td>4000 EUR</td>
<td>3000 EUR</td>
</tr>
<tr>
<td>O2 90 MHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry 100 MHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1&amp;1 70 MHz</td>
<td>31,000 EUR</td>
<td>30,000 EUR</td>
</tr>
<tr>
<td>DT 50 MHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BASF 50 MHz</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total fee = 1000 + B x t x 5(a1 + a2)

Risk of interference

Private local network (3.7 – 3.8 GHz)

Public macro-cellular network (3.4 – 3.7 GHz)

The use of different uplink and downlink traffic patterns in private and public networks lead to different frame structures and technical complexities to manage risk of interference.
5G 2B projects in UK at 3800-4200 MHz

Licence to deploy as many base stations as required within a circle of 50 metre radius. Terminals are licence exempt.

Annual fee / licence: £80/(10 MHz)
A user can apply for multiple licences

9 licensees as of January 2021:
(licensing available since December 2019)
- Quickline Communication Ltd.
- Telent Technology Service Ltd.
- Vodafone Limited
- Netmore IoT Solutions Ltd.
- University of Warwick
- BlueWave Communication
- Toshiba Europe Ltd.
- BCP Council
- Integrated Digital Service Ltd.
Finland: National licensing of large blocks + leasing obligations

- No spectrum fragmentation for the very valuable 5G primary band.
- The “use-it-or-lease-it” obligation ensures that the industrial users will get the connectivity they need.
- Exploiting and contributing to the 3GPP economies of scale.
- Allowing to leverage on all MNOs’ spectrum assets (low, mid- and high bands).

Finland’s approach

- Telia: 130 MHz
- Elisa: 130 MHz
- DNA: 130 MHz
Norway: national licensing + access and spectrum rental obligations

- 3400-3800 MHz
  - 4 blocks of 40 MHz, and 24 blocks of 10 MHz
  - Cap: 120 MHz
  - Obligation to provide access for industrial and business player
  - Licensees required to provide access through the provision of special solutions in the form of customized services or private networks, based on reasonable tender requests. The obligation is supplemented by a rental obligation where the holders are required to rent out frequencies for a limited geographical area for the establishment of a separate 5G solution.
- 2300 and 3800-4200 MHz to be released in 2023.
Recommendations (1)

- The connectivity and spectrum requirements of industrial users should be carefully assessed (for the many different use cases) to formulate evidence-based policies.

- **Priority:** Provision of services by MNOs through nationwide spectrum licensing of low and mid-bands associated with:
  
  - Obligations on MNOs for provision of special solutions to industrial use in the form of customized services or private networks through network slicing.
  
  - Facilitated leasing of spectrum from MNOs by industrial users.

- **Alternative:** Local licensing could be considered as a second step in case industrial users’ connectivity requirements cannot be addressed by MNOs’ wide area networks. MNOs should not be excluded from acquiring local licenses.
Recommendations (2)

RSPG draft opinion on RSPP:

“RSPP should encourage and incentivise more efficient spectrum use, avoiding fragmented use as much as possible.”

- Local licensing leads to spectrum fragmentation that is not easily reversible, and should not be applied in the current and future 5G primary bands (i.e., should not compromise availability of large contiguous bandwidths for high performance nationwide networks).
  - Current 5G-NR primary bands: 3400-3800 MHz, 26 GHz.
  - Future candidate 5G-NR primary bands: 2300, 3800-4200, 6425-7125 MHz.

RSPG draft opinion on spectrum needs:

“Recommends to investigate the possible use of the band 3.8-4.2 GHz for local vertical applications while protecting receiving earth stations and other existing applications and services.”

- If local licensing is considered for the 3800-4200 MHz band:
  - It should be applied only to a portion of the available band (based on a careful assessment of user requirements).
  - Leaving the possibility for the rest of the band to be used for nationwide or wide-area assignments (if this is compatible with the need to protect incumbent users).
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Spectrum sharing

- We note that the issues of *inter-service* and *intra-service* spectrum sharing often get conflated, and result in misunderstandings.

- Broadly speaking, *spectrum sharing* should only be considered where there is a clear demand for additional spectrum which otherwise cannot be made available, and where the benefits outweigh the costs.
Recommendations: Inter-service sharing

- We acknowledge that the growing demand for terrestrial mobile broadband connectivity, and the fact that frequency re-planning or clearance of incumbents to allow IMT deployments may not be possible in all cases, mean that increasing levels of spectrum sharing between IMT networks and other services may be inevitable going forward.

- As such, the mobile industry has been very active in recent years in establishing efficient inter-service spectrum sharing frameworks at a global level in order to allow more extensive use of the scarce spectrum resource subject to least restrictive technical conditions.
Recommendations: Intra-service sharing

- Spectrum sharing in general – and especially complex proposals for intra-service spectrum sharing\(^1\) – should not be considered as goals in themselves but must bring tangible net benefits to users of spectrum.

- We consider that existing spectrum authorisation frameworks based on individual licensing and licence exemption in distinct frequencies respectively, as available today, are sufficient to cater for all foreseen intra-service spectrum sharing scenarios for innovative use cases.

- Where there might be demand for dynamic/opportunistic intra-service spectrum sharing, these can already be catered for in licence exempt bands. Therefore, we do not see a need for additional spectrum sharing frameworks\(^1\) to cater for such dynamic/opportunistic use.

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\(^1\) Some stakeholders are advocates for frameworks where commercial entities (e.g., IT/internet companies) take over the role of spectrum management, and operating independently of regulators, and having themselves not paid for access to spectrum, grant the right to use the spectrum resource on a dynamic and opportunistic basis to users in exchange for a fee. We do not support such approaches.