Global 5G spectrum update and innovations for future wireless systems
Today’s Agenda

ONE
Global 5G deployments are well underway, using low, mid, and mmWave spectrum bands

TWO
More spectrum is needed for future wireless growth; our spectrum innovations can open new capacity

THREE
We are advancing novel spectrum sharing technologies that can realize new levels of utilization and efficiency

FOUR
Questions?
Global 5G deployments are well underway

Using low, mid, and mmWave spectrum bands
Driving digital transformation across industries

5G will enable $13.1 Trillion in global sales activity in 2035

Source: The 5G Economy, an independent study from IHS Markit, commissioned by Qualcomm Technologies, Inc., November 2020
5G continues to expand globally

- 245+ operators with 5G commercially deployed
- 270+ additional operators investing in 5G
- 1B+ 5G connections globally
- 6B+ 5G smartphones to ship between 2020-2026
- 1,800+ 5G devices launched or in development

Sources: 5G commercial networks, operators investing in 5G, 5G devices launched: GSA, Mar 2023; 2023 5G connection projections - average of Ericsson (Feb 2023) and GSMA Intelligence (Feb 2023); 5G cumulative smartphone shipments - average of CCS Insight (Sept 2022), IDC (Dec 2022), and Strategy Analytics (Oct 2022).
5G operates in all spectrum types / bands

Lifeblood of wireless communications

Licensed spectrum
Exclusive use
Remains the industry’s top priority

Shared spectrum
New shared spectrum paradigms
e.g., 3.5 GHz USA, 3.8-4.2 GHz UK, 37-37.6 GHz USA

Unlicensed spectrum
Shared use
e.g., 5 GHz / 6 GHz / 60 GHz global

HIGH BANDS
ABOVE 24 GHz
(mmW A V E.)

MID BANDS
1 GHz — 7 GHz

LOW BANDS
BELOW 1 GHz
Dynamic Spectrum Sharing (DSS) has allowed 5G to be deployed in existing LTE brands.

Efficient spectrum use with low sharing overhead
5G NR to avoid resources used by LTE
No impact to legacy LTE devices

Source: Qualcomm Internal
Global snapshot of allocated/targeted 5G spectrum

5G is being designed for diverse spectrum types/bands

<table>
<thead>
<tr>
<th>Spectrum Type</th>
<th>Licensed</th>
<th>Unlicensed/shared</th>
</tr>
</thead>
<tbody>
<tr>
<td>600MHz (2x35MHz)</td>
<td>900MHz (2x35MHz)</td>
<td>2.5/2.6GHz (B41/n41)</td>
</tr>
<tr>
<td>700MHz (2x30 MHz)</td>
<td>3.4-3.8GHz</td>
<td>5.9-6.4GHz</td>
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<tr>
<td>700MHz (2x30 MHz)</td>
<td>3.4-3.8GHz</td>
<td>26GHz</td>
</tr>
<tr>
<td>700MHz (2x30 MHz)</td>
<td>3.46-3.8GHz</td>
<td>5.9-6.4GHz</td>
</tr>
<tr>
<td>700MHz (2x30 MHz)</td>
<td>3.6-3.8GHz</td>
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<td>3.3-3.6GHz</td>
</tr>
<tr>
<td>700/800MHz</td>
<td>2.3-2.39GHz</td>
<td>3.4-3.7GHz</td>
</tr>
<tr>
<td>700/800MHz</td>
<td>2.3 GHz</td>
<td>3.6-4.1GHz</td>
</tr>
<tr>
<td>600MHz (2x40 MHz)</td>
<td>700MHz (2x30 MHz)</td>
<td>2.3 GHz</td>
</tr>
</tbody>
</table>

NEW 5G BAND

- Licensed
- Unlicensed/shared
**RECENT HIGHLIGHTS**

**5G Global Spectrum Status**

**North America**

- Multiple bands in commercial deployment from all major mobile operators, e.g., 600 MHz, 2.5/2.6 GHz, 3.5 GHz, 28 GHz, as well as other existing bands using DSS
- 4.9 GHz band targeted for public safety use with non-commercial secondary use
- 5.9 GHz band for automotive safety - waiver granted by FCC to permit initial C-V2X deployments
- 6 GHz band (5.9-7.1 GHz) for unlicensed operations (e.g., Wi-Fi and 5G NR-U)
- 5030 MHz band (5030-5091 MHz) for UAS operations
- Lower 37 GHz band - advanced spectrum sharing possibilities

**United States**

- Multiple bands in commercial deployment from major mobile operators, such as 600 MHz, 3.5 GHz, and other mobile bands using DSS

**Canada**

- Looking to open 3.9 GHz band and 26, 28, and 38 GHz bands for exclusive use and for non-competitive local (NCL) licensing
- Above 95 GHz bands opened by ISED for unlicensed operations

Source: GSA
5G
Global Spectrum Status

**RECENT HIGHLIGHTS**

**ARGENTINA**
- 5G Auction announced for 2023 (no specific date) for the 3.3-3.6 GHz band.

**BRAZIL**
- Assigned 3.3-3.7 GHz and 26 GHz. Reserved 3.7-3.8 GHz for local networks.
- Considering and consulting on 4.8-5.0 GHz band.

**COLOMBIA**
- 5G Auction scheduled for Q3 2023 in the 3.3-3.7 GHz and 26 GHz bands.
- Assigned 3.3-3.4 GHz, 3.6-3.65 GHz, and 26 GHz for 5G. 3.4-3.6 GHz pending reorganization.
- 3.75-3.8 GHz range reserved for local networks.

**MEXICO**
- Assigned 3.4-3.45 and 3.45-3.55 GHz for 5G.
- Evaluating 3.3-3.4 GHz and 26 GHz. Trying to recover the 3.3-3.35 GHz range.

**PERU**
- Fragmented assignment 3.4-3.6 GHz.
- Evaluating 3.3-3.4 GHz, 3.6-3.8 GHz, and 26 GHz bands

**URUGUAY**
- Assigned 27.5-28.25 GHz for 5G (via temporary assignments).
- Auction rules approved for 3.3-3.4 GHz, and 3.6-3.8 GHz bands. Auction expected in Q2 2023.
5G Global Spectrum Status

**Europe**

**U.K.**
- Assigned 3.4-3.8, 3.8-4.2 for private networks
- 26 GHz, 40 GHz authorization framework under definition

**ITALY**
- Assigned 3.4-3.8 GHz
- Assigned 26 GHz

**FRANCE**
- Assigned 3.4-3.8 GHz
- Test licenses for 26 GHz band

**SPAIN**
- Assigned 3.4-3.8 GHz
- Assigned 26 GHz - including dedicated spectrum for private networks

**SWEDEN**
- Assigned 3.4-3.8 GHz
- Assigned 26 GHz - including dedicated spectrum for private networks
- Local licensing in 24.25-25 GHz

**GERMANY**
- Assigned 3.4-3.7 GHz, 3.7-3.8 GHz for private networks
- 26 GHz licenses issued on demand on a local basis

**FINLAND**
- Assigned 3.4-3.8 GHz
- Assigned 26 GHz - including dedicated spectrum for private networks

**GREECE**
- Assigned 3.4-3.8 GHz
- Assigned 26 GHz

**SLOVENIA**
- Assigned 3.4-3.8 GHz
- Assigned 26 GHz band

**ROMANIA**
- Assigned 3.4-3.8 GHz
- Planned assignment for 26 GHz

**ESTONIA**
- Assigned 3.4-3.8 GHz
- Assigned 26 GHz
- Assigned 3.5-3.8 GHz, local license 3.4-3.5GHz

**CZECH REP.**
- Assigned 3.4-3.8 GHz
- Assigned 26 GHz

**DENMARK**
- Assigned 3.4-3.8 GHz
- Assigned 26 GHz

Source: GSA
### 5G Global Spectrum Status

#### China
- Assigned 700MHz, 3.4-3.6 GHz, 4.8-5.0 GHz for 5G
- Allocated 3.3-3.4 GHz for shared indoor use
- Refarming 900 MHz 2G/4G band for 5G
- Identify IMT service in 24.75-27.5 GHz and 37-43.5GHz (portion thereof)

#### Hong Kong
- Assigned 3.3-3.6 and 4.84-4.92 GHz
- Allocated 400 MHz per operator in 26/28 GHz, with 400 MHz reserved for local licensing

#### Taiwan
- Assigned 3.3-3.57 GHz for 5G
- Assigned 27.9 - 29.5 GHz, with 27.0-27.9 GHz held for future allocation
- 4.8-4.9 GHz planned for local networks

#### Japan
- Allocated 3.6-4.1 GHz, 4.5-4.6 GHz, and 27-28.2, 29.1-29.5 GHz to 4 operators
- 4.6-4.8 GHz planned for local licensing
- 4.8-4.9 GHz planned for assignment
- 4.9-5 GHz, 26.6-27 GHz, and 28.3-29.1 GHz 39.5-43.5 GHz are being planned

#### South Korea
- Allocated 3.4-3.7 GHz and 26.5-28.9 GHz
- On-going consideration for 3.7-3.8 GHz band
- MSIT plans to allocate additional 5G spectrum
- Assigned 3.4-3.7 GHz
- 3.7-4.2 GHz, 4.4-4.5 GHz, 4.8-5.0 GHz under on-going consultation
- 26 GHz mmWave band for local licensing and wide-area allocation

#### Australia
- Assigned 3.4-3.59 GHz and 3.59-3.8 GHz
- 26/28 GHz mmWave under consideration

#### New Zealand
- Assigned 3.4-3.59 GHz and 3.59-3.8 GHz

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Source: GSA
**RECENT HIGHLIGHTS**

**5G**

**Global Spectrum Status**

- **India**
  - Assigned spectrum across all bands for 5G, including 600, 700 MHz, 3.4-3.67 MHz and 26 GHz to 4 operators
  - 800, 900 MHz, 1.8, 2.1, 2.3, and 2.5 GHz bands currently used for 4G, but expected to become 5G bands

- **Singapore**
  - Assigned upper mid-band 3.45-3.65 GHz to two operators with 100 MHz each
  - Assigned mmWave in 26.25-29.5 GHz for 4 operators with 800 MHz each
  - Consulting on 4.4-5.0 GHz band

- **Malaysia**
  - Planning to assign 3.5 GHz and 26/28 GHz band, which was delayed from 2020

- **Thailand**
  - Assigned 2.5 GHz TDD spectrum for 5G
  - Assigned 26 GHz spectrum to 4 operators
  - Planning to assign 3.4-3.7 GHz

- **Indonesia**
  - Conducted trials in 28 GHz
  - Targeting 2.3 GHz band for sub-7 GHz
  - Consultation for 3.3-3.6 GHz in upper mid-band and mmWave in 28/28 GHz bands

- **Philippines**
  - Assigned 3.3-3.8 GHz in mid-band
  - mmWave spectrum under consideration

- **Vietnam**
  - Planning to assign 3.6-4.0 GHz, with temporary assignment for testing in 3.7-3.8 GHz band
  - On-going consultation on 4.4-4.8 GHz
  - Planning to assign 26/28 GHz

*Source: GSA*
Global snapshot of spectrum optimized for industrial IoT / vertical / private network use

Local licensing or sharing

<table>
<thead>
<tr>
<th>Country</th>
<th>Frequency Ranges</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>3.5 GHz CBRS, exclusive &amp; shared licenses</td>
<td>2575 - 2615 MHz, 26.5 - 27.5 GHz (test licenses)</td>
</tr>
<tr>
<td>GERMANY</td>
<td>3.7 - 3.8 GHz</td>
<td>703 - 708 / 758 - 763 MHz (Infrastructure segment)</td>
</tr>
<tr>
<td>U.K.</td>
<td>3.8 - 4.2 GHz</td>
<td>1487 - 1517 MHz, 2490-2495 MHz, 2.4 GHz, 295 GB LTE</td>
</tr>
<tr>
<td>SWEDEN</td>
<td>1780-1875 MHz</td>
<td>703 - 708 MHz</td>
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<tr>
<td></td>
<td>3720 - 3800 MHz</td>
<td>27.5 - 27.9 GHz</td>
</tr>
<tr>
<td></td>
<td>24.5 - 25.1 GHz</td>
<td>2300 - 2325 MHz</td>
</tr>
<tr>
<td>FINLAND</td>
<td>3410 - 3450 MHz</td>
<td>Sub-licensing of 3.4 - 3.8 GHz, 24.5 - 25.1 GHz</td>
</tr>
<tr>
<td></td>
<td>3750 - 3800 MHz</td>
<td>2300 - 2325 MHz</td>
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<tr>
<td></td>
<td>28.2 - 29.1 GHz</td>
<td>24.72 - 24.82 GHz</td>
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<td>1755-1785 MHz in remote areas, 1920-1980 MHz in remote areas</td>
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<td>3.7 - 4.0 GHz for local area licensing</td>
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<tr>
<td>TAIWAN</td>
<td></td>
<td>2575 - 2615 MHz, 26.5 - 27.5 GHz (test licenses)</td>
</tr>
<tr>
<td>CHINA</td>
<td>Issued the first 5G trial license in 5925-6125 MHz and 24.75-25.15 GHz to COMAC</td>
<td></td>
</tr>
<tr>
<td>SINGAPORE</td>
<td>Each operator has acquired 800 MHz of 26/28 GHz spectrum to deploy local networks</td>
<td></td>
</tr>
<tr>
<td>JAPAN</td>
<td>2.575 - 2.595 MHz and 1.888.5 - 1.916.6 MHz (NSA anchor)</td>
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<tr>
<td></td>
<td>4.6 - 4.9 GHz (4.6 - 4.8 GHz indoor only, 4.8 - 4.9 GHz outdoor possible) &amp; 28.2 - 28.1 GHz (Outdoor use; total 250 MHz 28.2 - 28.45 MHz)</td>
<td></td>
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<tr>
<td>SOUTH KOREA</td>
<td>4.72 - 4.82 GHz and 28.9 - 29.5 GHz for 5G specialized local applications</td>
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<tr>
<td>NETHERLANDS</td>
<td>4.8 - 4.9 GHz for 5G local private and enterprise licenses</td>
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</tbody>
</table>

Source: GSA, MFA
Enabling 5G sidelink for public safety and commercial use cases

Targeting 4.9 GHz PS band in US

4940 to 4990 MHz band in Jan. 2023 FCC NPRM

Primary public safety spectrum to support first responders during emergencies

Sidelink is 3GPP standardized and supports priority and preemption for public safety while allowing secondary commercial uses

Enabling sidelink in all devices will greatly improve public safety services throughout the country, including where there is no cellular coverage
More spectrum is needed for future wireless growth

Our spectrum innovations can open new capacity
Spectrum is the “lifeblood” of future wireless innovations

Fully realize the 5G potential and lay groundwork for the 6G future

**Immediate Term**
Focus on commercializing 5G mmWave in a timely manner to meet rapidly growing capacity and user experience requirements

**Short-to-Medium Term**
Focus on opening additional lower-band capacity to fuel the growth of 5G
Advanced use cases

**Longer Term**
Focus on identifying, studying, clearing, and allocating new bands for sustained growth into 2030 and beyond

- Downtown hotspots
- Indoor enterprises
- Transportation hub
- Fixed wireless access
- Industrial IoT
- Venues
- Advanced automotive connectivity
- Private network innovations
- Wide-area IoT evolution
- Powering the metaverse
5G mmWave can address near-term capacity needs

Complementing low/mid-band to deliver meet massive bandwidths for broadband and beyond

- **Multi-Gbps speeds**
  - With large bandwidths (100s of MHz)

- **Much more capacity**
  - With dense spatial reuse

- **Lower latency**
  - Bringing new opportunities
5G mmWave serves congested areas with high-level performance

RootMetrics study shows mmWave can deliver more uniform user experiences even in congested network.

mmWave provides speeds 4-5x faster than those of low-band and mid-band in congested conditions.

mmWave delivers on the promise of providing extreme capacity and blazing-fast speeds under heavy network loads.

Source: https://www.rootmetrics.com/en-US/content/mmwave-cutting-through-congestion
5G mmWave did the **heavy lifting** at Super Bowl 57

**5G mmWave carried 73% of all indoor cellular downlink traffic**\(^1,2,3\)

Ubiquitous 5G mmWave coverage in the stadium with two mmWave bands\(^2\)

64% of all users were mmWave capable

**Excellent mmWave user experience**

- 2.6 Gbps downlink average throughput per user
- 119 Mbps uplink average throughput per use

**Excellent 5G network performance**

- 138% more cellular traffic in the stadium compared to Super Bowl 56

**Bringing massive capacity and new experiences to venues**

1. Data from the bowl seating area for 4G and 5G
2. 1600 MHz of mmWave spectrum activated (devices utilizing a maximum of 800 MHz in downlink)
3. 5G NR sub-6 GHz bands: 60 MHz in mid-band and 10 MHz in low-band. LTE sub-6 GHz bands: 50 MHz with 4 DL CC CA
4. Multiple Wi-Fi locations did not have any throughput and those results are not shown here
mmWave is ready for global commercial accelerations

5G mmWave devices launched or announced by 65+ vendors

Countries assigned, planning to assign, or in ongoing consultation of 5G mmWave spectrum

Source: GSA, December 2022

Source: GSA, March 2023
Key Agenda Items

1.1 — IMT in the 4.8-4.99 GHz band
Considers conditions for which the band 4800-4990 MHz could be used by terrestrial component of IMT. It addresses technical and regulatory conditions, such as power flux density (pfd) limits, which could protect aeronautical and maritime mobile services.

1.2 — IMT in the 3.5 GHz, 6 GHz, and 10-10.5 GHz bands
Considers identification of bands 3300-3400 MHz (Region 2 and amend footnote in Region 1), 3600-3800 MHz (Region 2), 6425-7025 MHz (Region 1), 7025-7125 MHz (globally), and 10.0-10.5 GHz (Region 2) for IMT including possible allocations to the mobile service on a primary basis.

1.3 — Mobile use of the 3.6-3.8 GHz band in Region 1
Considers possible primary allocation in Region 1 to the mobile service (except aeronautical) in the band 3600-3800 MHz.

1.5 — Consideration of sub-1 GHz spectrum in Region 1
Reviews the spectrum use and needs of existing services in the band 470-960 MHz in Region 1 and considers possible regulatory actions in the band 470-694 MHz in Region 1.

10 — Plan, support harmonization, and secure availability for new 6G coverage band
Proposing an agenda item for WRC-27 to study key upper mid-bands for 6G across all 3 regions, i.e., 7.125-15.35 GHz.
5G Advanced on the path to 6G

5G

Rel-15
Rel-16
Rel-17
Rel-18
Rel-19
Rel-20
Rel-21+


5G Advanced
2nd wave of 5G innovations

Continued 5G evolution in the 6G era

Next technology leap for new capabilities and efficiencies

IoDTs

Service requirements

Study Item (proposals)

Work Item Trials

Vision forming

Foundational research

3GPP 6G Workshop

Continued 5G evolution

IoDTs

Vision forming

Foundational research

3GPP 6G Workshop

Rel-20

Rel-19

Rel-18

Rel-17

Rel-16

Rel-15

5G

A unified platform for innovations

2021 2022 2023 2024 2025 2026 2027 2028 2029 2030+

WRC-27

WRC-23

WRC-19
Propelling next-level experiences and innovative use cases in the new era of the connected intelligent edge for 2030 and beyond.
6G will need new mobile spectrum

Wide bandwidths (e.g., 500 MHz) will be key to success of next-generation wireless systems.

Studies on new bands need to begin today in preparation for WRC-27 (e.g., focused on 7.1–15.3 GHz range).

**Coverage**
- Low Bands: Below 1 GHz
- Mid-Bands: 1 GHz – 7 GHz
- Upper Mid-Bands: 7 GHz – 24 GHz
- Millimeter Wave Bands: 24 GHz – 100 GHz
- Sub-THz Bands: 100 GHz & Beyond

**Licensed Spectrum**
- Exclusive spectrum remains mobile industry’s top priority

**Unlicensed Spectrum**
- Shared use but no QoS guarantee

**Shared Spectrum**
- Evolving spectrum sharing to enable fair and more reliable shared operations
New upper mid-band brings order of magnitude more wide-area capacity
Offering larger contiguous bandwidths – targeting 500 MHz to 1 GHz licensed spectrum per operator for 2030 and beyond

- Delivering new capacity for wide-area broadband (e.g., smartphones, smart cities, automotive, verticals)
- Fueling scalable boundless XR user support in wide area through wider bandwidth availability
- Supporting high-resolution RF sensing for new use cases (e.g., environmental monitoring, activity detection)

Focusing on lower 9 GHz of the “FR3” Upper Mid-Band i.e., 7 to 16 GHz

Wide-area coverage of sub-7 GHz with multi-Gbps capacity of mmWave

Opportunity to co-site with existing sub-7 GHz deployments for comparable coverage in higher band
Upper mid-band (i.e., 7 - 16 GHz) is expected to become the next wide-area coverage spectrum. Bringing expanded capacity but also more challenging propagation conditions due to higher frequency.

MWC'23 demonstration: Giga-MIMO in upper mid-band
Making sub-Terahertz spectrum viable for communications and beyond

Building on our mmWave experience to address key system challenges challenges at higher band spectrum

Use case feasibility
Evaluating diverse use cases, form factor requirements and how sub-THz can deliver effective solutions

System design
Building early prototypes to overcome implementation challenges (i.e., device formfactor, power consumption, etc.)

Propagation loss
Using intelligent beamforming to overcome path loss, penetration loss, foliage loss, and others
With sub-THz communication in the 145 GHz band, we can achieve speeds up to 300 Gbps and latencies below 100 microseconds.

MWC’23 demonstration: Sub-THz (145 GHz) OTA testbeds
We are advancing novel spectrum sharing technologies

Realizing new levels of utilization and efficiency
Spectrum sharing can work well in all spectrum types and bands.

- **Licensed Spectrum**: Exclusive spectrum remains mobile industry's top priority.
- **Unlicensed Spectrum**: Shared use but no QoS guarantee.
- **Shared Spectrum**: Evolving spectrum sharing to enable fair and more reliable shared operations.

Critical for the success of next-generation wireless systems.
A decade of leadership in unlicensed spectrum
From LTE-U/LAA to NR-U

Vision: High-performance cellular in unlicensed spectrum

Continuous research, industry first over-the-air LAA, eLAA, MulteFire demos, co-existence with Wi-Fi
Rel-16 introduces NR in unlicensed spectrum

Anchored NR-U
Unlicensed spectrum is combined with other licensed or shared spectrum as anchor

Unlock more spectrum globally

Standalone NR-U
Only unlicensed spectrum is used

New deployment scenarios

Unlock more spectrum globally

New markets and verticals

* Still under discussion in Rel-16
Standardized in 5G NR Release 16:
First global cellular standard with both license-assisted and standalone use of unlicensed spectrum

< 1 GHz
Low-bands (sub-1)

1-7 GHz
Mid-bands (sub-7)

24+ GHz
High-bands (mmWave)

Unlicensed Spectrum Bands in 3GPP

- Available now
- Under study / review
U.S. - 3.5 GHz CBRS provides a 3-tier shared spectrum paradigm

150 MHz for flexible use while protecting government incumbent systems

**TIER 1**
Incumbents

- Military radar: ship-based
- Military radar: ground-based

**TIER 2**
Priority Access Licenses (PAL)

- PAL

**TIER 3**
General Authorized Access (GAA)

- GAA

1 Wireless ISP transitioning from incumbent to PAL/GAA after 5 years; 2 Fixed satellite service - receiving only; 3 Citizen Broadband Radio Service (CBRS)
Evolution to licensed spectrum sharing for improved efficiency, flexibility, and user experience

<table>
<thead>
<tr>
<th>Offering improved spectrum utilization and reduced spectrum cost</th>
<th>Unlocking new spectrum that may require non-exclusive licensing and sharing with primary users</th>
</tr>
</thead>
<tbody>
<tr>
<td>MNO can reuse spectrum of other MNOs when their spectrum is not in use</td>
<td>Designing for efficient and coordinated spectrum sensing / sharing that improves overall system performance</td>
</tr>
<tr>
<td>Building on years of 4G and 5G spectrum innovations</td>
<td>Leveraging O-RAN architecture to allow operators to cost-efficiently offer service and preserve differentiations (e.g., through O-RU sharing)</td>
</tr>
<tr>
<td></td>
<td>Utilizing adaptive AI/ML to address high-mobility scenario and public / private networks coexistence in the same band</td>
</tr>
</tbody>
</table>
Giga-MIMO improves coexistence with other systems

Compared to previous generations, we expect 6G design to account for sharing with non 3GPP systems, i.e., implementing a “sharing by design” approach.

Giga-MIMO allows tight control of very narrow beams in upper midbands that in the presence of incumbent systems can lead to new and more efficient coexistence approaches.

Specific sharing mechanisms will depend on the target bands and incumbent systems.

Flexible new 6G air interface design with native support for spectrum sharing
Advanced mmWave spectrum sharing

FCC Proposal for lower 37 GHz band

Driving continued mobile mmWave technology evolution

Showcasing advanced technology-neutral spectrum sharing in mmWave frequency bands

Outperforming uncoordinated spectrum sharing in quality of service

Combining the benefits of licensed and shared spectrum for higher network capacity and a better user experience
O-RAN spectrum sharing brings many benefits, including improved resource utilization, new deployment flexibilities, and more.

- Provides flexible, scalable framework for spectrum and equipment sharing while allowing service differentiation
- Improves spectrum utilization while supporting guaranteed QoS
- Enables faster and more cost-efficient deployments
- Promotes fair market competition with an open, standardized interface
- Drives towards sustainability goals and closing the digital divide
O-RAN’s flexible architecture offers multiple deployment possibilities

**Shared O-RU**
- Multiple MNOs can share O-RUs, spectrum can be owned by MNO(s) or a third party

**Individual O-RU**
- MNOs can share spectrum and cell sites while still maintaining their own O-RUs

**Hybrid O-RU**
- MNOs can share spectrum and have a mix of shared and owned O-RUs

**Private Network**
- Public MNOs and private networks share both spectrum and O-RUs
Improving access in unlicensed spectrum bands

FCC adopted Contention Based Protocol (CBP) rule for 6 GHz to provide protection to incumbent primary operations and regulate medium access.

- Supports advanced transmitter techniques, such as coordinated multi-point (CoMP)
- Enables coexistence among multi-technology deployments
- Coexists with asynchronous access devices

Synchronous access enables advanced spectrum utilization techniques

Synchronous access enables better spectral efficiency for 6 GHz unlicensed band
Global 5G

spectrum updates and innovations for future wireless systems

Global 5G deployments are well underway, using low, mid, and mmWave spectrum bands.

More spectrum is needed for future wireless growth, our spectrum innovations can open new capacity.

We are advancing novel spectrum sharing technologies that can realize new levels of utilization and efficiency.
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