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Securing the right spectrum for 5G

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The rush to implement terrestrial 5G services has already begun, with the mobile broadband industry being guided to deploy networks in different radio frequency bands.

The mobile broadband industry and the International Telecommunication Union (ITU) have already traveled quite far along the road to 5G. However, when it comes to the radio frequency spectrum issues, the road is not always straight. To secure the right 5G spectrum, there are still significant efforts needed to align allocations between countries. This is an urgent matter, as 5G networks are already being deployed in new frequency bands.

At the World Radiocommunication Conference in November 2019 (WRC-19), the member states of the ITU are expected to agree on new 5G spectrum allocations within the high bands (24.25GHz to 86GHz range). These bands are often referred to as the "millimeter wave" (mmWave) bands, and are central to supporting a wide range of new industry applications using 5G New Radio (NR) technology specified by 3GPP.

For 5G services to be successful in meeting the demands on data speeds and capacities, the agreements at the WRC-19 between the ITU member states will need to provide enough spectrum bandwidth in the right bands and under the right conditions. In this context, "conditions" refers to the requirements of use within a certain band, including co-existence with uses in adjacent bands.

The business landscape

Mobile data traffic is projected to increase by eight times over the next six years. New applications – such as augmented reality (AR), virtual reality (VR) and other increasingly immersive video formats – are emerging, along with growing demands on security and reliability. In addition, billions of new connected Internet of Things (IoT) devices are expected, with a large variety of business cases and requirements on mobile networks.

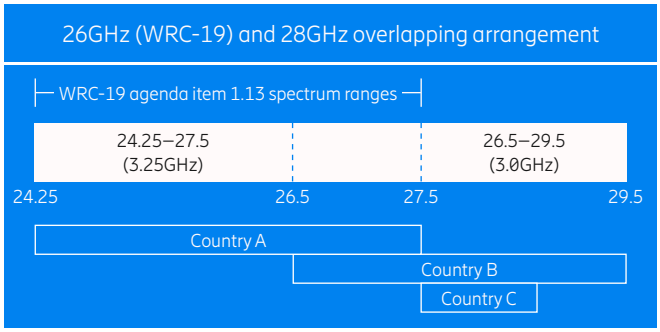
To support these demands, 5G service providers will need sufficient spectrum bandwidth. As radio wave propagation properties differ by spectrum band, it will be important to secure a combination of bands to meet both coverage (low/mid-bands) and capacity requirements (high bands).

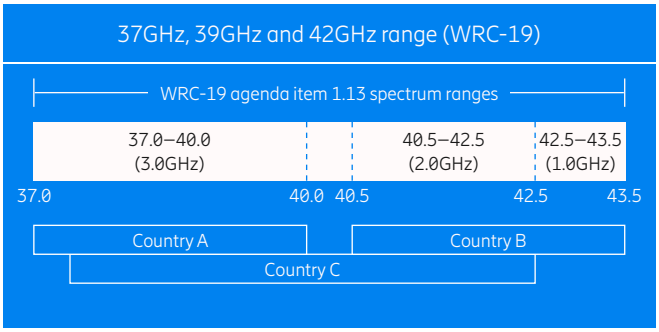
Many of the low bands considered for 5G services have already been agreed upon by the ITU (WRC-15 or earlier). Now member states are responsible for deciding how to allocate this spectrum within their respective countries. As mentioned, decisions related to the high bands are planned to be agreed upon at the WRC-19.

Even so, as the rush to deploy 5G continues, many countries have already taken actions to allocate certain bands – both before the WRC-19 and outside the scope of the WRC-19 agenda item 1.13. This will allow for quicker deployments of 5G services but will also require dedicated efforts to harmonize these allocations between those countries.

For 5G to be successful in meeting the demands on data speeds and capacities, global harmonization of spectrum is essential.

Two examples of where spectrum harmonization can create opportunities to establish "tuning ranges"





The 5G spectrum bands

The high bands expected to be deployed early on for 5G include the 28GHz band, as well as the 26GHz, 37GHz and 39GHz bands. The 28GHz band may be used in certain countries by the end of 2018 or early 2019, while the other high bands are estimated to be available in late 2019.

Low bands below 1GHz are of interest due to their favorable radio wave propagation characteristics, as they provide coverage in remote areas and into buildings. A new band in the 600MHz range is expected to be made available by the end of 2018 for 5G services.

Part of the mid-bands between 1GHz and 7GHz is also expected to be allocated in many countries. Mid-bands within the 3.3GHz to 5GHz range will likely be made available around 2020 and are seen as important spectrum resources for terrestrial 5G access networks. The mid-bands are particularly beneficial as they offer a favorable "middle ground" between propagation characteristics (coverage) and bandwidth (capacity).

There are, of course, a number of spectrum bands already in use by service providers. In general, all the current 3GPP bands including low bands (600MHz, 700MHz, 800MHz, 850MHz and 900MHz) and mid-bands (1.5GHz, 1.7GHz, 1.8GHz, 1.9GHz, 2.1GHz, 2.3GHz and 2.6GHz) are being considered for 5G services in the future. These bands, and composite arrangements of these bands, will be central to delivering 5G coverage and capacity for enhanced mobile broadband, IoT, industrial automation and mission-critical business cases, as well as for Public Protection and Disaster Relief (PPDR) services.

In addition, 3GPP has recently started a separate Study Item to investigate the feasibility of using the 6.5GHz band (5,925MHz to 7,125MHz) for 5G services.

The importance of harmonization

As previously discussed, many countries are not waiting for 5G regulations and specifications to be completed at the WRC-19; they are already taking steps toward commercial 5G NR, with a particular focus on the spectrum range 26.5GHz to 29.5GHz (the 28GHz band). Examples include:

- In the United States, the Federal Communications Commission (FCC) has already adopted regulations governing mobile use in the 28GHz range (suggesting that satellite use will be secondary), as well as applying additional regulatory conditions. The 37GHz and 39GHz bands are also being prepared for early use.
- South Korea carried out a successful pre-commercial 5G trial using the range 26.5GHz to 29.5GHz during the Pyeongchang 2018 winter sports events. This activity was in preparation for commercial deployment, which is expected to follow a spectrum auction of the 28GHz band during 2018.
- Japan will be deploying fully commercial 5G networks for the 2020 summer sports events in Tokyo. In 2018 and 2019, the country is also carrying out a larger-scale pre-commercial field trial within the 3.7GHz, 4.5GHz and 28GHz frequency ranges.
- Regulators in Europe and China aim to deploy commercial 5G networks in the 26GHz range by 2020. In addition, they have expressed interest in subsequent deployments in the 42GHz range.
- India is considering the range 24.5GHz to 29.5GHz for commercial 5G networks, as well as the bands 37GHz, 39GHz and 42GHz.

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Given these activities, international harmonization of the discussed spectrum bands remains critical for the development of 5G. Countries may not always be able to use the exact same frequency bands within a certain spectrum band. The mobile industry is trying to solve this deficiency by establishing technical "tuning ranges". These are frequency ranges where the industry is able to technically mitigate that bands are being deployed differently in different countries, while still being able to develop handsets and devices that can roam between countries and be used transparently from a consumer point of view. Keeping frequency allocations within these tuning ranges would greatly benefit the industry as a whole. It would allow economies of scale to be captured for network infrastructure, mobile broadband devices and IoT devices.

In the figures above, two possible examples are shown where frequency allocations within tuning ranges have a significant positive impact. The frequency bands in the WRC-19 agenda item 1.13 are mapped over the bands being allocated by a number of the leading countries deploying 5G. If more countries adhere to these tuning ranges, the ability of 5G services to reach a global scale would significantly increase.

More advanced 5G services require wide bandwidths

In countries where 5G NR services will be deployed early, it is important to address the risk of not having a sufficient amount of licensed spectrum. Advanced 5G services are anticipated to provide significantly higher peak data rates and capacity. This will require spectrum resources to be allocated in very wide bandwidths. The need for both speed and capacity suggests that an aggregate bandwidth of 10GHz to 15GHz or more (implemented over time) will be required for these services. This means that gigahertz-wide channel blocks in bands in the 24.25GHz to 86GHz range will be needed. This is another aspect of 5G spectrum allocation that needs to be taken into account at the WRC-19.

Backhaul spectrum is key for 5G transport networks

Another key issue to be discussed at the WRC-19 is the need for additional backhaul capacity. Eventually, refarming of some of the current microwave frequency bands (such as 26GHz and 28GHz) will be required to support 5G access networks. These developments might seem to be in conflict, but they can be handled with appropriate national spectrum management.

For instance, the 32GHz band (31.8GHz to 33.4GHz) is being studied for the WRC-19 for 5G mobile access networks. However, due to limited support within the ITU, it is being positioned more as a key microwave backhaul replacement for the refarming of the 26GHz and 28GHz bands and is thus regarded as a strong candidate for a global backhaul band.

The E-band (71GHz to 76GHz paired with 81GHz to 86GHz) is an essential backhaul band of high global alignment. However, in preparation for the WRC-19, it is also being studied for 5G mobile access use. The E-band offers very wide bandwidth, enabling throughputs in the order of 10Gbps or more over several kilometers. With a microwave multi-band booster concept, like carrier aggregation in access networks, these distances can be further extended to around 10 kilometers.

In the longer term, it is clear that more backhaul spectrum will be needed to support throughputs of up to 100Gbps. In preparation for evolving 5G backhaul demands, the specifications of the W-band (92GHz to 115GHz) and D-band (130GHz to 175GHz) are being finalized in Europe and have recently started in the United States.

Local licenses for private networks

The development of private networks requiring local licensing also needs to be taken into account. A number of countries are considering awarding (or enabling service providers to lease) spectrum for local use.

Countries that wish to make spectrum available to entities on a more local basis could limit those allocations to real-estate defined areas, such as factories. This is a national decision and it is still unclear if and how countries will realize possible allocations for private networks.

National licensing of the right spectrum, in sufficient amounts, to terrestrial mobile broadband providers is fundamental to creating momentum for 5G service deployments.

Actions to realize the full potential of early 5G deployments

To realize the full potential of early terrestrial 5G network deployments and to meet the growing demands on network performance, significant efforts are required worldwide to reassign spectrum from underutilized applications to 5G services. This process will be most beneficial to service providers, industries and consumers if:

- Internationally harmonized high-band arrangements are applied
- Bandwidth to meet 5G access performance demands is awarded
- Spectrum for high-throughput backhaul systems is assigned
- Appropriate conditions for spectrum use are applied
- Tuning ranges are considered

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