The urgency of full low-band (sub-1GHz) spectrum release for mobile

By Coleago Consulting – 20 November 2020

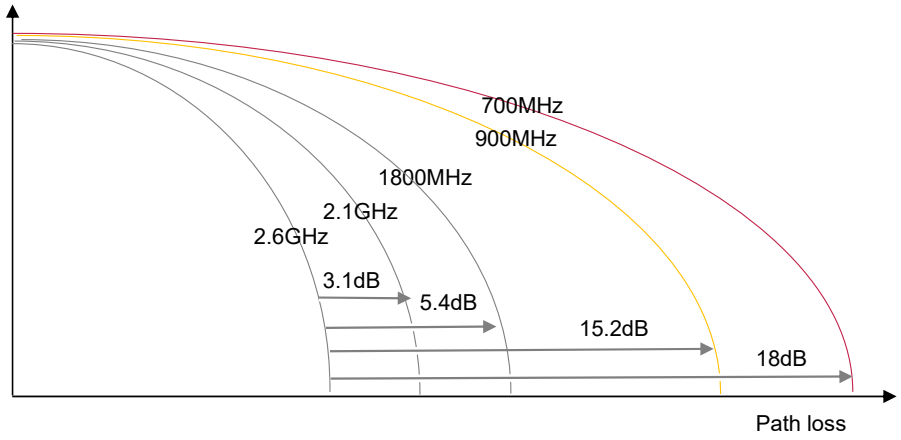
Mobile Network Operators (MNOs) need to continuously expand capacity to meet the rapid growth in mobile data consumption. Crucially, this extra capacity needs to be delivered where demand arises, including deep indoors and in areas that are covered by fewer mobile radio sites.

New spectrum is vital for the rapid delivery of performant mobile broadband services at widely accessible prices. However, simply increasing the total MHz of available mobile bandwidth is not sufficient: MNOs need the right mix of low-, mid- and high-band spectrum to keep pace with demand across their entire networks.

Low-band versus high-band spectrum

Lower frequencies have superior propagation characteristics. For example, 900MHz yields a coverage gain of around 15.2dB compared with 2.6GHz[1], leading to improved indoor and wide-area coverage. However, low-band spectrum designated for mobile is scarce, and there is less scope to extend its capacity by deploying higher order MIMO enhancements.

Coverage comparison



In contrast, far more bandwidth is available in high bands, some of which also allow massive MIMO (mMIMO) implementations. The technical differences can result in capacities per MHz that are more than 4x higher in the 3.4-3.8GHz range, for example, than below 1GHz. Trading off higher data throughputs for improved coverage is also possible with mMIMO technologies, allowing 3.4-3.8GHz spectrum to emulate the propagation characteristics of mid-band spectrum such as 1800MHz and 2100MHz. However, the indoor penetration levels and site coverage areas achievable at such frequencies are still substantially less than those obtainable with low bands.

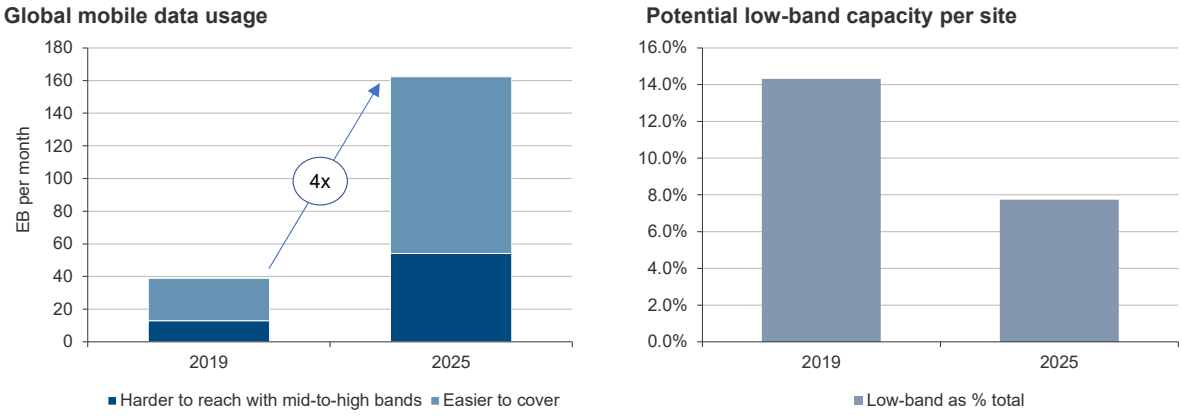
In short, high-band spectrum awards enable large increases in capacity at the site air interface (which is certainly important), but this does not provide capacity everywhere it is needed.

Mobile consumption and spectrum utilisation patterns

The GSMA projects a 4-fold increase in global mobile data traffic between 2019 and 2025[2], much of which will be difficult to address with mid- and high-band spectrum.

According to further analysis quoted by the GSMA[3], over 80% of mobile data consumption occurs indoors, where mid- and high-band coverage is weaker. A significant proportion of this demand is carried by the limited amount of low-band spectrum held by MNOs. Rural broadband access also relies heavily on low-band resources. While rural access usually accounts for a small proportion of total traffic, it is critical for digital inclusion.

These patterns are reflected in the high utilisation rates of low-band spectrum currently observed across different markets. Crowdsourced network data published by Tutela suggests that low bands carry around a third of all 4G traffic[4]. Yet low-band spectrum deployed for 4G today typically accounts for less than 15% of total available 4G bandwidth. Assuming that all mobile-designated spectrum up to 3800MHz is allocated and deployed for 5G, the capacity per site provided by sub-1GHz bands could be less than 8% of the total. Furthermore, a proportion of low-band capacity will continue to be set-aside to support residual 2G and 3G traffic, leading to less efficient use of bandwidth. This includes legacy machine-to-machine (M2M) communications, which are likely to endure because it is impractical to replace the large number of connected devices that are already deployed in the field.



Clearly, given the projected growth in mobile data demand, the low bands will face severe congestion well before mid- and high-band capacity is exhausted.

Low band is essential to meet national broadband objectives

The release of additional low-band spectrum (below 1GHz) is essential to meet key policy objectives articulated in national broadband plans, both in emerging and developed markets. Mobile broadband is quicker to deploy than fixed-line alternatives, and with sufficient low-band spectrum, it is usually a more cost-effective way of reaching users in less densely populated areas, which is key to bridging the digital divide.

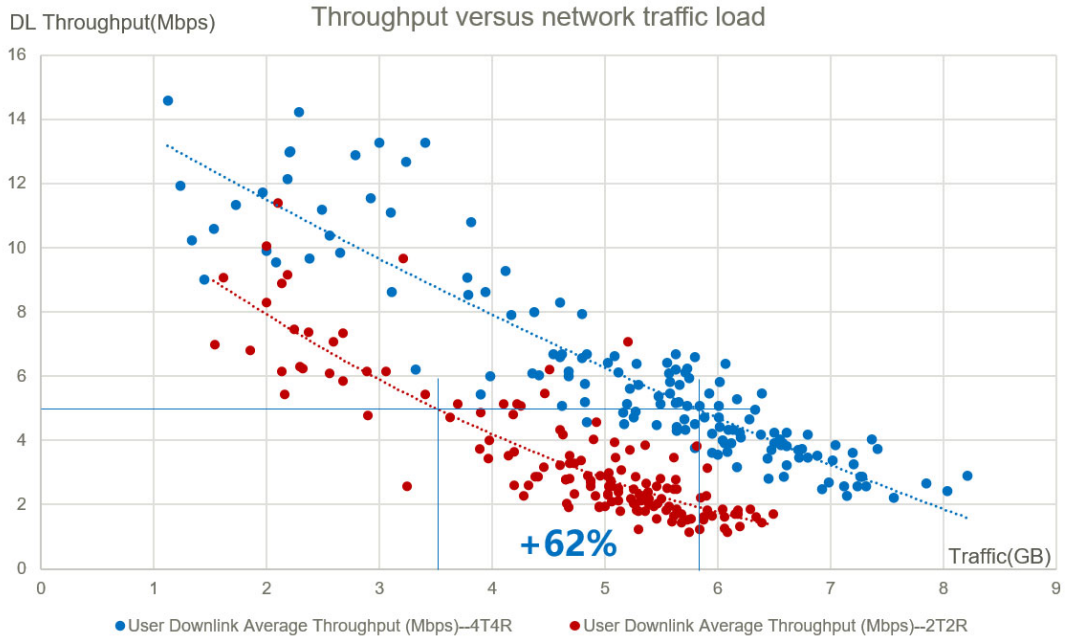
While low-band spectrum is typically more expensive per MHz than the higher bands, population coverage has been prioritized over direct licence fee income by regulators in several countries. For example, low-band spectrum fee discounts have been offered in exchange for mobile broadband coverage obligations in Sweden, the UK, Germany, Ghana, Denmark, Colombia, and Nepal. Such policies explicitly recognise the high socio-economic value of digital participation.

Deploying 4T4R can significantly improve low-band spectrum efficiency

Given the high scarcity and value of low-band spectrum, improving the efficiency with which it is used is paramount. Cell-edge users, especially indoors, impose a disproportionate burden on mobile networks. Because they often cannot be reached with the higher bands, they tend to cause low-band congestion and reduced overall quality. Even though smartphones can only support two low-band antennas (due to size constraints), deploying 4T4R MIMO technology in sub-1GHz spectrum allows MNOs to dramatically increase cell-edge capacity and performance.

When low- plus mid-band spectrum is co-deployed, as is common in urban areas, the proportion of low-band resources absorbed by cell-edge users is typically higher. This is because users that are closer to the centre of the cell mostly camp on mid-band, which has higher camping priority than low band. Tests performed on commercial 900MHz plus 1800MHz LTE networks suggest that in this scenario, low-band 4T4R can produce a net gain of 62% in 900MHz average capacity relative to 2T2R.

LTE 900M commercial performance: 4T4R versus 2T2R



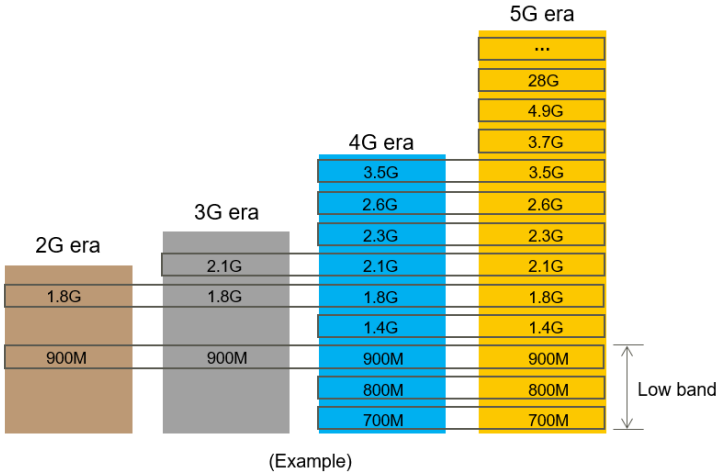
Multi low-band deployment is a key trend in the 5G era

With the evolution of radio access technologies from 2G and 3G to 4G and 5G, multi low-band deployments are emerging as a key trend addressing the growth in data traffic as well as the rising user-experience expectations of customers. The possibility of aggregating multiple low bands within a single RF module substantially increases cost-effectiveness hence investment efficiency.

Multiple low-band is an evolution trend in 4G to 5G era

Multiple low-band deployments allow:

- Deeper urban coverage with great capacity;
- Wider rural coverage with good experience;



(Example)

Many countries have already allocated low-band spectrum in line with their national broadband strategies, to speed up and extend access to data services. Some MNOs already hold spectrum in three low bands. These include all incumbent MNOs in Germany, France, the Netherlands, Denmark, Norway, and the UAE; Telia, DNA and Elisa in Finland; Telia and Net4Mobility in Sweden; and MTN in Cameroon. All the above have licences in 700MHz, 800MHz and 900MHz.

However, a high proportion of MNOs worldwide still only have access to low-band spectrum in a single band, because mobile-designated low-band frequencies have still not been released.

Call to action: regulators

To the extent mobile-designated sub-1GHz spectrum is still available, low-band should be prioritized in the spectrum allocation roadmap and regulators should accelerate its release. Specifically, the 700MHz band is quasi-globally harmonised for mobile use, yet it remains unallocated in numerous markets. In some jurisdictions, even 800MHz spectrum is yet to be released. Following the auction of 2x35MHz at 600MHz in the US, the band is now available in a wide range of smartphones. It could potentially be awarded to mobile across ITU Region 2, including Latin America. Where necessary, regulators should seek to migrate broadcast TV frequencies to free up spectrum that is internationally designated for mobile use.

Not only will additional low-band spectrum boost overall broadband availability and improve customer experience: it is essential for future voice communications and messaging, among of the most important of all use cases, and it is necessary to build a fully connected world. VoLTE is the foundation for enabling 5G voice calls and rich communications services (RCS). Implementing these in low bands will ensure that they can be accessed deeper indoors and in more remote locations. The superior coverage achievable with low bands will also underpin future M2M connectivity based on 5G NB-IoT and LTE CAT1 standards, driving further economic productivity and growth.

New low-band usage rights should be released on a technology neutral basis, to allow operators to make the most efficient use of it. The assignments should also be planned carefully to minimise potential interference degradation caused by passive intermodulation (PIM). Wider contiguous channels should be favoured, to promote more efficient use of spectrum. When renewing expiring 900MHz licences, for example, regulators should take the opportunity to reorganise the band to address any existing fragmentation within the band. In addition, spectrum trading should be encouraged, to allow MNOs to swap low-band holdings with a view to create wider channels in fewer bands.

Incremental spectrum usage rights should also be awarded for long durations or on a perpetual basis, to promote investment in spectrum roll-out across networks. Longer licence durations provide greater certainty to MNOs, thus reducing investment risk and incentivising more extensive deployment.

Finally, regulatory policy should be focused on optimising mobile market outcomes rather than on spectrum fee maximisation. Excessive licence fees tend to drive higher retail prices and starve MNOs of capital to invest in networks and services. The negative resulting impact on mobile broadband adoption and usage leads both to reduced consumer welfare and foregone gains in economic productivity and growth. These potentially outweigh the social gains from direct licence receipts by up to two orders of magnitude[5], and would threaten the future recovery from the Covid-19 crisis. In the worst case, excessive reserve prices lead to unsold (hence unused) spectrum.

Call to action: MNOs

It is also in the interest of MNOs, of course, to ensure that spectrum is used efficiently. They should seek to create or pursue opportunities to consolidate low-band spectrum holdings through bilateral or multilateral spectrum trading. Failing this, MNOs should implement dual- or triple low-band aggregation to improve cell-edge performance while maintaining hardware investment efficiency, exploiting the possibilities generated in the 5G era (notably the scope to deploy multiple low bands within the same RF module).

Extending their 4-5G coverage to match their existing 2-3G footprint would accelerate customer migration from legacy technologies to 4-5G, enabling MNOs and their customers to get the most out of the available spectrum resources.

Deploying 4T4R MIMO across their low-band holdings will allow MNOs to drive higher performance and busy-hour capacity across their network.

Finally, MNOs should target cell-edge throughputs of at least 6 Mbps in the downlink and 2 Mbps uplink, to meet the minimal requirements for HD streaming, online education, and video conferencing[6], without which mobile could not legitimately be described as a broadband service.

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[1] Based on simulations using Okumura-hata HW and cost231-hata HW propagation models.

[2] See the 'The Mobile Economy 2020', available at: https://www.gsma.com/mobileeconomy..

[3] See the 'GSMA Small Cell Deployment Booklet', available at: https://www.gsma.com/publicpolicy/wp-content/uploads/2016/12/GSMA_Small_Cell_Deployment_Booklet.pdf.

[4] Based on data published by Tutela covering the US, UK, Germany, Switzerland and Austria. The arithmetic mean proportion of 4G traffic carried by sub-1GHz spectrum in each of these markets ranged between 21% and 45%, with a sample mean of 32% and median of 34%. See https://www.tutela.com/blog.

[5] See Thomas W Hazlett, Roberto E. Muñoz, "What really matters in spectrum allocation design", 2012, available at: https://scholarlycommons.law.northwestern.edu/cgi/viewcontent.cgi?article=1159&context=njtip.

[6] See in particular the bandwidth requirements for group HD video calls published by Zoom, available at: https://support.zoom.us/hc/en-us/articles/207347086-Group-HD. The minimum uplink for sending 1080p video call is 1.8Mbps in 1:1 HD video calling, and 3Mbps for group video. According to the Encoding.com Knowledge Base, 6Mbps is usually needed to download standard-definition DVD content; see: https://help.encoding.com/knowledge-base/article/understanding-bitrates-in-video-files/.