Progressive spectrum policy is as critical to 5G backhaul as it is to the RAN

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It is well-known that increased spectrum capacity is required to support 5G access networks, and this spectrum must be usable and affordably for all operators. However, it is much less well-known that 5G backhaul has the same requirements.

Backhaul networks must be upgraded to unlock the full performance potential of the 5G radio access network (RAN) and to avoid bottlenecks. It is easy to assume that such an upgrade will always involve fibre. In fact, approximately 70% of sites (outside of east Asia) currently use wireless links for backhaul, and a variety of different technologies must be used to backhaul 5G cells in order to achieve the optimal balance between cost and performance across the whole network.

5G will require a backhaul upgrade, but a fibre-only approach will not be cost-effective in all environments

Fibre will be essential for many high-capacity cells, but it is certainly not the only solution. Indeed, it may be too expensive to deploy (relative to the traffic and revenue potential of the site) in rural areas and for smaller cells. Wireless backhaul, using microwave or millimetre wave spectrum bands, can be used alongside fibre and is a high-performance, yet flexible and cost-effective, solution. Using emerging spectrum bands in higher frequencies will also ensure that wireless backhaul capacity is suitable for 5G.

Using wireless backhaul to complement fibre will be particularly important in making it affordable for operators to expand their 5G networks quickly to rural and remote areas, which is critical to narrowing the digital divide between urban and rural communities that exists in many countries. Closing this divide is a key element of many governments' digital roadmaps, yet it will be economically impossible unless wireless backhaul plays a significant role.

The E-band may be key in opening up new 5G backhaul capacity

5G backhaul will need new sources of spectrum (as is the case in the RAN) as well as new technologies to maximise the efficient use of that spectrum. However, new spectrum is currently being allocated around the world to support the expected tenfold growth in 5G capacity, and wireless backhaul is having to rely on only slightly more spectrum than it had for 4G.

The most promising sources of new spectrum for backhaul are the high-frequency bands, particularly the E-band (70–80GHz) that supports wide 2GHz channels. This can provide plentiful capacity in a relatively untouched area of the radio spectrum, and can be a very valuable complement to the traditional, mid-band backhaul frequencies, which support longer distances than the E-band, but have lower capacity. The E-band is therefore considered to be essential to driving the performance of non-fibre cells to the level required for 5G.

A combination of high-frequency and mid-band spectrum will enhance an operator's ability to balance capacity and cost in the most efficient way (as in the RAN). It will provide a good quality of experience for all users, including those in rural areas, while keeping costs in line with the revenue potential.

This will only happen if E-band spectrum is affordable for operators to acquire and use, and is allocated in a way that supports their business models. So far, regulators in 86 countries have released E-band spectrum for commercial use, and it is important that others follow suit. Regulators need to ensure that the fees are affordable in order to stimulate the adoption of wireless backhaul and therefore accelerate rural 5G roll-outs.

It is also important that the rules attached to the spectrum allocation align well with mobile operators' economics. For instance, microwave backhaul spectrum is often issued on a per-link basis, but this means that the spectrum capacity required, and therefore the costs, rise linearly with an increase in traffic. It is far more efficient to receive spectrum that covers blocks of territory, in the same way as RAN airwaves. This gives operators the flexibility to deploy spectrum where it is most needed within a territory, using as many links as required, thereby greatly improving the quality of service and economics.

New techniques for improving efficiency will also help to optimise the quality of experience

5G usage will stretch the limits of the available backhaul spectrum, even in the bands where it is plentiful, such as the E-band. As such, spectral efficiency is critical to 5G economics in areas where wireless backhaul will be heavily used (such as rural areas). Technology that can help to improve this efficiency include the following.

- **Multi-band links.** These bind two spectrum frequencies on a single link in order to combine the benefits of two bands, such as the E-band (short range and high capacity) and spectrum in the 10–23GHz band (longer range).

- **Cross-polar interference cancellers (XPIC).** These can double the capacity of a microwave or E-band link while reducing interference between the links. The benefits are multiplied when used in conjunction with multi-band solutions.

- **Multiple input multiple output (MIMO).** This is also a key feature of 5G access. It supports directional beamforming to improve data rates and range using arrays of antennas. Each antenna adds another carrier to the channel, thereby increasing capacity almost linearly.

The combination of these efficiency techniques with E-band and microwave spectrum enables wireless backhaul to support the full 5G experience for very large numbers of users and enterprises, which would be difficult to achieve affordably using fibre backhaul. This will have significant impact on how quickly the socio-economic objectives of 5G, including the closing of the digital divide, can be achieved.

It is therefore essential that operators are not too fibre-centric, but instead are open to deploying a flexible combination of many backhaul technologies. It is even more critical that regulators recognise that wireless backhaul will not diminish in importance in the 5G era, but that it will require large amounts of spectrum to be freed up, affordably and on a block (rather than link) basis. A forward-looking regulatory regime will encourage operators to innovate in their microwave backhaul networks, and to use them to accelerate their 5G build-outs to communities everywhere.