Spectrum above 6GHz for future mobile communications

EE Response to Ofcom Call For Input

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BASIC DETAILS

Consultation title: Spectrum above 6 GHz for future mobile communications

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Representing (self or organisation/s): EE

Address (if not received by email):

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Name Andy Sutton Signed (if hard copy)

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Introduction

EE welcomes Ofcom's call for input on Spectrum above 6GHz for future mobile communications and the opportunity to respond.

Our responses below focus on the questions of this call for input which are of greatest relevance to EE as an operator of mobile access networks and fixed links.

Response to Consultation Questions

Question 1: Are there practical ways of achieving the very high performance that use of wide channels above 6 GHz could offer, for example using carrier aggregation of lower frequency bands?

Techniques such as carrier aggregation and higher-order MIMO offer some improvements in the sub-6GHz bands however there simply is not enough spectrum available in these bands, even when aggregated, to meet the anticipated longer term requirements. There are practical implementation limits on what is possible with MIMO at an acceptable cost point and in an acceptable form factor. Availability of wider channels in higher frequency bands will offer simpler and cost-effective techniques for achieving the higher peak and average data rates along with increasing overall area capacity density and acting as a catalyst for the development of new applications and services. Research to date suggests that gains from massive MIMO are greater in the higher frequency bands however further research is required across all frequency bands to understand what is possible.

Question 2: What recent or emerging advances in technology may provide effective solutions to the challenges in higher frequency bands? For example can increased propagation losses be mitigated by using the high gains available with massive MIMO?

A large number of antennas in the user equipment and at the base station will enhance the link performance in the higher frequency bands for line of sight conditions through beam-forming techniques. More robust waveforms (for example, Filter Bank Multi-Carrier modulation) will help to compensate for loss due to diffraction and reflections in non-line of sight conditions. The evolving concept of ultra dense networks will help as small cells operating in the higher frequency bands will be tightly packed and therefore path length to a given UE will be minimised. Additionally it is likely that dedicated solutions will be deployed for in-building coverage with an anchor connection being maintained on sub-6GHz spectrum, emanating from indoors or outdoors. Of course bands above 6GHz covers a wide range of different propagation characteristics; those between 6 and 10GHz for example may well offer reasonable building penetration whereas those much higher will not. The challenge of outdoor-in coverage requires much research including industries beyond the cellular and traditional radio communication

domains; building designers and materials scientists could add significantly to this debate and should be consulted as part of a wider holistic approach to future communications requirements for the 21st Century.

Question 3: Are there any fundamental/inherent frequency constraints of the 5G technologies currently being investigated with regard to:

a) minimum contiguous bandwidth per operator? Will the spectrum for multiple operators need to be contiguous (i.e. a single band) or could multiple operators be supported through multiple bands?

b) frequency range over which the technologies are expected to be able to operate, for example due to propagation, availability of electronic components, antenna designs and costs of deployment? For example, is 10-30 GHz better or worse than 30-50 GHz and why?

a) Ideally a wide-band of contiguous spectrum per operator would be available however there are techniques related to carrier aggregation to realise wider logical channels from multiple narrower allocations, albeit with some additional complexity in comparison with single wider channels that will be possible above 6 GHz. It is essential that International harmonisation of any new spectrum is realised to ensure a mass market economic for equipment and systems operating at these frequencies. It is unlikely to be practical to support many higher frequency bands in devices, due to component costs and complexity, therefore great care must be taken to select those bands which offer the greatest overall benefits.

b) The lower the frequency the greater the range for a given set of parameters however this does not address all likely deployment scenarios. While sub-6GHz spectrum continues to be essential for cellular communications due to its coverage properties; tight spatial reuse to enable ultra dense small cell deployments as part of an optimised heterogeneous network will be essential to realise the necessary improvements in area capacity density that can be achieved more efficiently with higher frequency spectrum from this spectrum. There are many well established vertical applications operating in these higher frequency bands today, certainly up to and including E-band (71-76 paired with 81-86GHz), therefore components and sub-systems are available and should drop in price with the mass market that 5G will generate.

Question 4: Will 5G systems in higher frequency bands be deployed, and hence need access to spectrum, on a nationwide basis or will they be limited to smaller coverage areas? And if so, what sort of geographic areas will be targeted?

Whilst we expect 5G systems and services to be deployed on a nationwide basis, the greater need for capacity density will clearly be in

urban and suburban areas. However this is not the only use case. In-building solutions will be deployed in many locations nationwide, and a range of special events are likely to require ultra dense networks in rural locations for short periods of time. We expect new services that would benefit from the capabilities of 5G - be they high peak or average data rates, ultra-reliability or low latency - to be required and offered on a national basis. This is important, to ensure we avoid creating a new geographical digital divide. Additionally nationwide applications will include in-vehicle systems, connected to the external network, along with certain vehicle to infrastructure applications. It is very likely that device to device communications (including vehicle-to-vehicle), operating in the higher frequency bands will be included in any future 5G standard. For these applications, a nationwide spectrum allocation is desirable.

Question 5:

a) To what extent will 5G systems in higher frequency bands need dedicated spectrum on a geographical and/or time basis or can they share?

b) If they can share, what other types of services are they likely to be most compatible with?

c) What technical characteristics and mitigation techniques of 5G technologies could facilitate sharing and compatibility with existing services?

d) Could spectrum channels be technically shared between operators?

To provide high quality, high performance mobile network services it is recommended that spectrum be allocated on a unilateral licensed basis. The higher frequency bands allow for dense spatial reuse; indoor and outdoor applications may offer sufficient isolation to enable co-existence between use cases. Sharing techniques are under study in several 5G research programmes; including 5GIC and METIS.

Question 6:

a) Given the capacity and latency targets currently being discussed for 5G how do you anticipate backhaul will be provided to radio base stations? Are flexible solutions available where the spectrum can be shared between mobile access and wireless backhaul?

b) What, if any, spectrum will be required? What channel sizes will be needed? Will the bands used be similar to those currently used for wireless backhaul?

a) It is anticipated that an ever increasing number of traditional cell sites will have fibre based backhaul however the need for wireless backhaul will still be significant. In urban and suburban areas it is likely that fibre

based backhaul will be provided for many sites. However as ultra dense networks are implemented to manage urban capacity requirements, there is likely to be a need for short range high capacity wireless backhaul as we do not expect it to be cost effective or indeed practical to connect fibre to every small cell site. 5G should ensure flexible use of radio spectrum assets such that in-band or self-backhauling is possible. Different use cases will drive different implementation techniques; urban areas with fibre may use a certain higher frequency band almost exclusively for radio access while rural use cases may rely on that band for a greater amount of the total area backhaul requirement.

b) Current microwave and millimetre wave bands will continue to play a role in cellular backhaul, with the acceptance that co-existence/self-backhauling will be a feature in any band(s) which are identified for 5G radio access. It is essential that new research into bands above 100GHz is initiated, there is some promising work on-going in the 92-95GHz band however we need to extend this scope, band up to 165GHz offer some opportunities while 200 to 300GHz has longer term potential. Long link lengths will always be required in certain rural use cases so suitable protection should be given to some of the lower microwave bands. Conversely it is very likely that links with ultra high capacity spanning some tens of metres will also be useful in urban areas and certain local rural clusters.

Question 7: Should we expand the scope of bands being reviewed beyond the 6-100 GHz range?

As discussed above; 5G should consider radio access and backhaul as one holistic research area and therefore yes, bands above 100GHz should be considered for backhaul however they are unlikely to be suitable for radio access.

Question 8: Do you agree that it is likely to be necessary for bands to have an existing allocation to the mobile service? Does this need to be a primary allocation?

Investigations into new bands should not be restricted to those with an existing mobile allocation. Other suitable bands should be considered and, if appropriate, a case made for modifying the allocation to include mobile services. This will clearly be more readily achieved in a band with lower current usage internationally.. It should be noted that 5G is likely to address many fixed network scenarios in addition to mobile. We are already seeing deployments of fixed broadband alternative services over 4G networks.

Question 9: Do you agree with the criteria we have used for our initial filter of bands, and are there other criteria that could also be used?

The approach seems reasonable (see answer to Q11 below). It is likely that 5G channels will be >100MHz wide and potentially as large as 5GHz, if suitable spectrum can be assigned.

Question 10: Of the spectrum bands/ranges mentioned in this section, are there any that should be prioritised for further investigation?

Research is at a very early stage with regards use of higher frequency bands for cellular radio access; it is recommended that a detailed and methodical approach is taken to understand the opportunities associated with each band. Detailed channel models are required to ensure all factors and environments are considered.

Question 11: Are there any bands/ranges not mentioned in this section that should be prioritised for further investigation? If so, please provide details, including why they are of particular interest.

METIS has identified the 31.8 to 33.4GHz band as a high priority. It appears this was filtered out of the analysis within this CFI due to lack of existing mobile allocation.

Questions 12: Are there any particular bands/ranges that would not be suitable for use by future mobile services? If so, please provide details.

As per answer to Q10, we should wait for the outcome of suitable research and practical measurement campaigns.

Question 13: What additional information, beyond that given in Annex 5 would be useful to allow stakeholders to develop their own thinking around spectrum options?

We believe that access to specific channel measurements and propagation field trials data would be very useful additional information for this purpose.

Question 14: What are the most important criteria for prioritising bands going forward?

The opportunity for global harmonisation of wide-band channels will be an essential criterion.