Cover sheet for response to an Ofcom consultation

BASIC DETAILS

Consultation title: **Ofcom Call for Inputs: Spectrum above 6 GHz for future mobile communications**

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Name _ _ _*Murray Niman* _ _ _ _ _ _ _ Signed (if hard copy)

Ofcom Call for Inputs on

Spectrum above 6 GHz for future mobile communications

Response from the Radio Society of Great Britain

February 2015

Introduction

This response to the above Ofcom Call for Input is from the Radio Society of Great Britain (RSGB, www.rsgb.org). The RSGB is the principal UK stakeholder representative body for Amateur Radio operators, with over 20,000 members, including many affiliated clubs and special interest groups. The latter include national groups with a core and active interest in microwave/millimetre-waves – UK Microwave Group, AMSAT-UK and BATC.

RSGB is also recognised as one of the leading organisations in the world in the field of amateur radio. It collaborates with its fellow national societies via the International Amateur Radio Union (IARU) through IARU Region-1 (www.iaru-r1.org).

Amateur radio is a science-based technical hobby enjoyed by over three million people worldwide. From a statutory point of view it is fully recognised by the International Telecommunication Union (ITU) as a Service and is listed in the ITU Radio Regulations as the Amateur Service and the Amateur-Satellite Service. Consequently the RSGB takes an active interest in spectrum allocations and relevant technologies.

Whilst not doubting the benefits of wireless broadband for society, we would caution whether there is a pressing need for regulatory action given how immature 5G technology is. A combination of WRC-15, UK-PSSR and the EU-RSPP will result in significant spare and potential spectrum capacity below 6GHz, partly at the expense of amateur allocations. This lower frequency spectrum will give the consumer a far better experience in terms of reliable coverage and connectivity (and battery life) – and be supplemented by low-cost high-speed technologies such as 60GHz WiGig.

Any identification of bands above 6GHz for 5G should be on a logical and focussed basis that has low impact for other incumbents who have already been squeezed by policies below 6GHz (and will have their own requirements for future spectrum above 6GHz). In that respect we welcome Ofcom's attempt to apply some filtering to the spectrum options, given that traditional sharing studies with definitive technical parameters will be impossible for years, as 5G is not yet defined/developed.

The Society welcomes further engagement with Ofcom on this challenging topic. Permission is granted for a copy of this response to be placed in the public domain.

RSGB, February 2015

General Position

Any future agenda item similar WRC-15 AI-1.1 and its ITU Join Task Group (JTG) exercise that would stretch over almost all usable spectrum would be potentially disastrous, costly and counterproductive.

Therefore the scope for this topic must be focussed and embedded into the relevant WRC-19 agenda item and defining resolution. With that in mind it should in the first instance be based on existing mobile service allocations and in particular Primary Mobile where there is ample spectrum above 6GHz. This basic definition could be supplemented by specific options such as re-use of wireless backhaul (Fixed Service), or 57-64 GHz (WiGig offload/mesh etc).

We would also highlight that a fundamental problem of the WRC/CEPT process is that sharing studies require technical parameters of the new system as well as incumbents. It will be years before 5G parameters will be known with any certainty. This even proved difficult to resolve for 5GHz Wi-Fi in the current cycle – let alone yet-to-be matured 5G technologies. The logic of this is that self-sharing within an existing Primary Mobile service allocation has to be the core option.

Allocations where it is well known that sharing is difficult are weak-signal/passive services. Therefore services such as Radiolocation, Radio-astronomy, Amateur and Amateur-Satellite should be excluded.

Questions and Answers

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?*

The premise quoted by Ofcom in 1.5 is already outdated. The consensus has already moved on from defining 5G by data-rate alone, to what the 'user experience' should be of always-on reliable connectivity. This will be achieved by UHF and existing frequencies, bolstered by supplemental download links (SDLs) such as the new 1.4GHz band, Wi-Fi etc.

Channel bonding/aggregation at lower frequencies should not be discounted. Within the foreseeable future around half of all spectrum between 400 MHz – 6GHz will eventually be available to mobile/Wi-Fi. Such bandwidth with the right waveform would be capable of delivering 1-10Gb/s from future software defined radios using low cost CMOS chip-sets.

This can be supplemented by existing WiGig technology in the 57-64 GHz license-exempt band, with no need for additional and complex millimetre-wave ITU WRC agenda items etc

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?*

MIMO is highly dependent on the degree of spatial correlation between multiple wavefronts. Given it spreads wavefronts out – it is inherently low gain (from a directivity point of view). Its benefits are also limited if the handsets/tablets etc can only support one or two transmit sources due to practical issues of size, packaging costs and battery life.

As ranges increase, it is more often the case that MIMO will never achieve its theoretical potential and is often closer to operating in diversity reception mode. As Ofcom indicate, massive spatial multiplexing (if affordable/practical) is likely to be only successfully applicable to very localised situations. For these, it may well offer better overall capacity – but it is far less likely to offer significant link budget gains, or magically solve fundamental propagation obstacles.

It is more likely therefore that advances in high frequency antennas (Smart antennas, phased arrays, on-chip-arrays etc.) will be more effective using directional beam forming. The 60GHz WirelessHD technology that used SiBeam on-chip arrays was a real example of this, as it could steer directional beams around and exploit alternative paths/reflections to get some coverage around corners/obstacles.

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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?*

Regarding 3a - this is not a technology issue. There is no inherent reason why spectrum or infrastructure cannot be shared, potentially on a more dynamic basis than at present in order to provide contiguous bandwidth-on-demand. The traditional model of static mobile operator allocations across disparate bands determined by high auction prices may well be inherently unsuited to 5G.

In respect of 3b, the rapid advance in high-integration CMOS technologies (driven by volume markets at 60GHz and 77GHz) has eliminated many of the barriers. This means it becomes more a matter of wafer processing economics. The small inter-element antenna spacing (for on-chip arrays) at millimetre-wave frequencies facilitates more chips per wafer, thus making higher bands a more economic manufacturing proposition than 10GHz.

Localised frequency-reuse also becomes easier at higher frequencies (notably around 60GHz due to Oxygen resonance losses), whereas compact high gains for longer ranges are most practical in the lower-loss 28-40GHz range (as exemplified by the majority of fixed link infrastructure that could potentially be re-purposed)

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?*

Given their limited range/power - urban settings and pico/femto-cells are far more likely than any rural/national coverage.

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?*

For 5a/b - There are more than enough Primary Mobile service millimetre-wave allocations. The only likely sharing scenario is where it may be deliberately similar frequency to its wireless backhaul (where sharing could be enabled by common hardware, network design etc).

For 5c - as highlighted earlier – no detailed sharing studies are conceivable at present, until 5G is developed further and its principle parameters are determined.

For 5d – as per our answer to 3a – there is no technical reason why this cannot occur. Ofcom auction/licence conditions should be fundamentally reformed and facilitate this to maximise spectrum efficiency by either inter-operator sharing, or from leasing from a third party infrastructure provider.

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?*

If 5G is to deliver Gb/s to end users, it is fundamentally obvious that the backhaul must have even higher capacity (or local intelligence/compression). The solution to this is not wireless spectrum, but optical. There must be a strong emphasis on fibre. Given that there is a nationwide rollout of fibre to phone exchanges and street cabinets (and potentially wider in urban areas) – this should be exploited in order to preserve valuable wireless spectrum for the mobile end-users.

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

No – if anything the scope should be narrowed! Industry has already indicated ranges such as ~20-50GHz or bands above ~28/30GHz. Lower bands have more incumbents and far less opportunities for contiguous spectrum blocks and should be excluded at an early stage.

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?*

Yes and YES

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?*

We generally agree with the Primary-Mobile focus in Section 3.3-3.6 but then suggest a weighting factor for where existing Fixed Service bands used for backhaul could be synergistically repurposed (as that is both spectrally efficient and similar technology). That logic tends to support, for example, the Intel, Samsung and similar work referred to later in Section-3 at 28, 39 and 60GHz

We would also point out a flaw in annex A5.33 (21-23GHz) where licence exempt can be largely discounted. Wideband automotive SRR is no longer permitted in new vehicles and had low sales in any case.

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

In Sec 3.9 Ofcom's range includes 42.5-52.6 GHz - but this should exclude the exclusive Primary amateur and amateur-satellite allocation at 47-47.2 where there is no Mobile allocation at all.

Otherwise as per our answer above – the focus should be where Mobile is already Primary (and may be synergistically used with the Fixed Service)

We agree with Ofcom with 'filtering' of others ranges from the FCC and METIS. For example it is clear that METIS background research for 10GHz was not well informed and agree with Ofcom's exclusion of it.

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.*

No comment

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

There are a number of weak signal / passive services which are not suitable, including astronomy, passive earth observation, radiolocation and Primary Amateur/Amateur-Satellite.

Therefore within the most likely range we would be most strongly opposed to 24.0-24.05GHz and 47.0-47.2GHz being included as these are globally harmonised Primary amateur bands.

In addition (given that WRC-15 is adding services to it) we are also opposed to lower bands such as 10-10.5GHz as its not only amateur – but there are minimal opportunities for harmonised large-bandwidth mobile usage

The other range we would have strong concerns with is the 75.875-76GHz range which has proven valuable in the UK for long distance amateur communications (up to 100km) and sits within a guardband between the 71-5GHz 4G links and the automotive radars.

In a move to 4/5G, we would expect that some of the original smaller IMT allocations will become unsuitable for the traffic levels and be abandoned. We would welcome a commitment to 'undesignate' these and potentially reallocate to other ITU services.

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?*

The annex gives useful detail regarding UK allocations and usage but the equivalent is needed at least at Regional level. Any down-selection also needs to be informed by what spectrum demand/plans there are from other services in the most likely frequency ranges (as briefly mentioned in Section-3.20).

Question 14: *What are the most important criteria for prioritising*

Both 5G and other services require maximum certainty and a repeat of the open-ended WRC-15 AI-1.1 exercise should be must avoided at all costs.

This requires that studies must be scoped and focussed on bands well above 10GHz where mobile is Primary (but where it could share with its own fixed links if necessary).

The nature/economics of high frequency CMOS technologies which would enable successful mass production suggest a focus on the ~28-40GHz ranges along with key slots at 60GHz and perhaps the 71/81GHz link bands.

It would be far better to identify common narrower ranges at an early stage, where the chipsets can be optimised for performance/battery-life as well as cost - than to keep too many options open and prolong uncertainty for 5G designers as well as incumbents.

The other key priorities should be to avoid regulatory obstacles, so that different operators can dynamically share frequency block capacity and for their backhaul to be largely fibre-based so that overall spectrum requirements do not become excessive.