ALCATEL-LUCENT

17th of February, 2015

Submission to the OFCOM

Ofcom Consultation on

Spectrum above 6 GHz for future mobile communications

Cover sheet

BASIC DETAILS

Consultation title: **Ofcom Consultation on spectrum above 6 GHz for future mobile communications**

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Address (if not received by email):

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Name Jean-Pierre Bonin Signed (if hard copy)

Introduction

Alcatel-Lucent welcomes the opportunity to respond to the Ofcom "Call for Input" (CFI) on "Spectrum above 6 GHz for future mobile communications".

The responses to the CFI reflect the views of Alcatel-Lucent in general and in the UK context in particular.

About Alcatel-Lucent (Euronext Paris and Nyse: ALU)

Alcatel-Lucent is the leading IP networking, ultra-broadband access and cloud technology specialist. We are dedicated to making global communications more innovative, sustainable and accessible for people, businesses and governments worldwide. Our mission is to invent and deliver trusted networks to help our customers unleash their value. Every success has its network.

For more information, visit Alcatel-Lucent on: http://www.alcatel-lucent.com, read the latest posts on the Alcatel-Lucent blog and follow the Company on Twitter: @Alcatel_Lucent.

Alcatel-Lucent's Responses

Alcatel-Lucent considers 5G to be a major step forward for mobile communications as we strive to offer higher and higher bitrates for a mass market mobile broadband service. With the evolution to 5G, mass market services will become more targeted offerings with network capabilities used to match the individual end user's actual requirements and individual circumstances.

Alcatel-Lucent shares the views of Ofcom that 5G is likely to make use of existing mobile bands, and/or of future bands below 6 GHz that might be identified for IMT, for instance at WRC-15, and also of new bands above 6 GHz. Therefore 5G will not make use of bands above 6 GHz only. There will be many ways diverse air interfaces and high and low spectrum bands will be used in concert for 5G, what we summarise with the term "federated radio access"

As provider of wireless backhauling solutions to mobile networks, Alcatel-Lucent urges Ofcom to consider the importance of fixed wireless services in high frequency bands even as technology innovations unlock these bands for mobile uses. Among other things, wireless backhauling is becoming increasingly important and must be given due consideration in this exploration of high spectrum bands.

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?

Alcatel-Lucent will first point out that the preliminary figures (10 to 50 Gbit/s) mentioned in support to this question (cf § 2.3 page 6 of the CFI document) refer to a parameter called "peak data rate", which is still under discussion.

This parameter is included in the Preliminary Draft New Recommendation IUT-R M.[IMT.VISION] as one of the key parameters for the evaluation of 5G systems.

The relevance of this parameter for the evaluation of the performance of a 5G network, and, if considered relevant, the minimum value that would be attached to it are both still

under discussion. A value of 20 Gbit/s has been proposed in the last version of the PDNR (February 2015), but remains not approved to date.

From our point-of-view a more relevant parameter for the evaluation of the performance of 5G networks would be the "user experience data rate" for which values of 100 Mbit/s to 1 Gbit/s are proposed.

Carrier Aggregation (CA) enables the combination of up to five LTE compatible carriers, either by intra- or inter-band combination. As such CA can provide bandwidths up to 100 MHz (5 times 20 MHz). CA combinations are specified by 3 GPP RAN4. Currently several three carriers DL CA scenarios have been defined for LTE Release 12, while four carriers DL CA scenarios are expected for Release 13.

Signalling support for Carrier Aggregation of up to 32 carriers will be included in LTE Release 13, paving the way for carrier combinations to be aggregated up to a total of 640 MHz. It is expected that such aggregation will include spectrum both below and above 6 GHz in the future.

However, CA of lower-band carriers is seen as a complement to, rather than an alternative to, the use of frequencies above 6 GHz. One reason for this is that aggregation of carriers in different bands has a negative impact on energy consumption, as it requires more hardware to be activated; it should be noted that a key objective of 5G will be energy efficiency. Device complexity also increases as the number of aggregated carriers and bands increases.

Further, the amount of spectrum available for aggregation below 6 GHz is very limited, and operators will certainly not be able to aggregate all their spectrum resources for 5G technology since they will in parallel have to continue to operate legacy technologies for many years to come.

In conclusion, using CA of bands below 6 GHz will certainly be a useful tool, but does not offer an alternative to bands above 6 GHz in dense hotspot areas where large bandwidths will be necessary to support very high traffic densities.

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?

Massive MIMO architectures can partly mitigate increased propagation losses by means of highly directive beamforming, but the degree to which mitigation is possible depends on the nature of the environment (i.e. indoor vs outdoor, urban vs suburban). Nevertheless, the size of cells will typically remain limited to some hundred meters, depending on the frequency band considered. Therefore bands above 6 GHz will be used mainly for small cells in order to provide additional capacity where required and will not be used to ensure global coverage. Advances in small cell technology such that the hardware becomes smaller and easier to deploy also mean that for larger numbers of small cells line of sight conditions can be achieved more easily.

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

> *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?*
>
> *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?*

In response to the second part of this question Alcatel-Lucent is of the view that some frequency bands within the range 20 - 50/60 GHz would probably present the best opportunities for future mobile communications above 6 GHz. This does not exclude the possibility to consider bands outside this range, depending on their ability to satisfy with the criteria listed below.

There are several criteria to be taken into account in the choice of frequency bands to be chosen, like for instance:

- Possibility to develop regional or, if possible, worldwide harmonisation, which means that the use of the band should preferably be already harmonised for another type of application.
- Use of these bands for backhauling operation: this is the case of several bands below 20 GHz (6 GHz; 7-8 GHz; 11 GHz; 13 GHz; 15 GHz; 18 GHz). This is why we do not think that bands below 20 GHz would present a high potential for mobile access systems. Backhauling is also developed in bands above 20 GHz (23 GHz; 26 GHz; 38 GHz) and is expected to develop in the E- and V-bands (see also response to Question 6). Therefore it is our view that in such cases of bands widely used for backhauling, mobile communications should be developed only if sharing between mobile and fixed networks is possible. In-band backhauling should also be considered, like for instance solutions based on mesh networks.
- Propagation conditions compatible with effective use for mobile communications. In our opinion this criterion may limit the attractiveness of bands above 50/60 GHz for mobile communications, except for very short range cells where the use would rather be stationary than fully mobile.
- Ability to co-exist with other applications / services. Generally speaking sharing of the spectrum may become easier in bands above 6 GHz due to the limited range of the systems, increased propagation losses and use of advanced antenna techniques ensuring greater directivity and therefore mitigating the potential sharing issues.

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?

Systems in higher frequency bands will be deployed mainly in dense urban environments to provide high data rate services. Other scenarios include special events and the connection of mobile users in public transportation. These scenarios would require wider area coverage, possibly outside high density areas. These scenarios are described in the preliminary draft new Report ITU-R M.[IMT.ABOVE 6 GHZ].

Consequently a nationwide coverage is not expected for these frequency bands, but rather an “archipelago” coverage consisting mainly of hot spots in indoor shopping malls or enterprises, dense urban areas and streets, etc.

This will not necessarily be confined exclusively to urban areas, as some enterprises may be located in suburban or even rural areas. Therefore nationwide licensing should likely remain the best way for the assignment of spectrum to operators, and to ensure them the possibility to develop high frequency solutions where they need to do without undue regulatory constraints.

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

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

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

Could spectrum channels be technically shared between operators?

a) Mobile systems in the bands above 6 GHz will operate under conditions which will require to deal with availability and quality of service requirements, and not just with best effort. In these conditions the use of dedicated licensed spectrum will remain necessary, at least for some of the bands identified for IMT above 6 GHz. As explained above we consider that nationwide licensing would ensure the best opportunity for the development of mobile neyworks above 6 GHz. Nevertheless the implementation of mobile systems in specific areas, as explained in response to Question 4, may facilitate sharing with other applications on a geographical basis. In some cases, where systems operating above 6 GHz would be installed on a temporary basis, for example in relation to special events which result in temporary high population densities in a limited area, sharing on a time basis could also be considered.
b) At this stage it is premature to answer this question.
c) The introduction of advanced antenna technologies (for instance adaptive beamforming as explained in answer to Question 2) could facilitate sharing with other applications / services. Increased propagation losses would also increase isolation and hence facilitate coexistence.
d) Sharing of spectrum channels between operators is a commercial matter.

Question 6: 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?

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?

Backhauling for broadband mobile access networks could be provided either by fiber optics or microwave links.

Microwave links can be especially useful in cases where fiber optics connections are not present or too expensive to install.

Access at bands above 6 GHz may also involve deployments with in-band backhauling in order to enhance coverage. This could for instance be based on mesh-type deployments.

Microwave links in the E-band benefit from 2×5 GHz frequency band: 71-76 GHz and 81-86 GHz. Microwave links in the V-band can operate within the 57-66 GHz band, generally under unlicensed or light licensing conditions.

Using modern modulation/coding schemes (up to 1024 QAM is now available) would allow the transmission of up to around 40 Gbit/s globally. Therefore microwave links operating in the E- and V-bands would provide a viable alternative to fiber optics in terms of capacity. Only the E-band or the V-band can provide so much contiguous spectrum for microwave links.

Backhauling of cells operating above 6 GHz will often require several hundred MHz or even several GHz. Channels for microwave links operating in the 60 GHz and 70/80 GHz bands are based on the flexible aggregation of elementary slots of 50 MHz and 250 MHz respectively. Aggregation allows the creation of channels with such sizes. Therefore in terms of channel size these bands are perfectly adapted to backhauling or fronthauling of cells operating above 6 GHz.

In several other frequency bands where microwave links are operating, channel sizes up to 112 MHz are currently defined. It would be possible, subject to the global range of the frequency arrangement and to the actual occupation of the band, to define larger channels

by aggregating several of these channels. Nevertheless it would generally be difficult to reach channel sizes similar to those of the 60 GHz and 70/80 GHz bands.

Microwave links in the V-band have already to co-exist with unlicensed short range broadband mobile broadband access technologies like WiGig, but specific propagation conditions in this band (characterized by a maximum oxygen absorption in the 60 GHz band) may facilitate coexistence which is expected to be feasible without implementation of any mitigation technique.

In conclusion we are of the view that the bands 57-66 GHz, 71-76 GHz and 81-86 GHz should remain fully accessible for further development of backhauling solutions, including point-to-point solutions. .

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

Alcatel-Lucent is not supporting the extension of the review beyond the 6-100 GHz band. We are rather of the view that the review could focus with priority to a smaller range, for instance from 20 GHz to 50 GHz or 60 GHz, considering cautiously the bands widely used for backhauling, and in any case considering how backhauling and mobile access could share these bands before identifying them for IMT.

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?

Alcatel-Lucent agrees that screening of the bands should concentrate with priority on bands already allocated to mobile service. This needs to be a primary allocation, as, even in the context of higher propagation losses, it is difficult to envisage the operation of IMT under a secondary allocation, and upgrading the status of the band at a WRC may be a challenging issue.

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

We agree with the two criteria considered by Ofcom for filtering the bands, ie:

- An existing global primary allocation to the mobile service in the Radio Regulations, and
- Contiguous bandwidth of at least 1 GHz,

But we propose to add additional criteria like:

- The ability for a global identification (very similar to the global primary allocation criterion, but a little bit more demanding as some bands globally allocated to the mobile service may have different legacy applications around the world which may affect the potential for a global harmonisation);
- The use for backhauling. The introduction of 5G is expected to increase the capacity requested to backhauling, and fiber optics will not be available in all circumstances. Therefore we should, as far as possible, preserve backhauling capacity, which will be useful for the development of 5G itself.

In practice the selection of frequency bands should result from careful consideration of these criteria, and of detailed consideration of the global benefits of their identification for IMT, including the need to ensure backhauling for existing and future IMT networks.

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

It is premature at this stage to definitively exclude any specific band for the investigations. Nevertheless we think that it may be useful to consider some priorities, by applying criteria like for instance those proposed by Ofcom and/or additional criteria like those suggested in question 9. With regard to the frequency ranges listed in section 3.9 of the CFI, this would result in the following priorities:

- 27-29.5 GHz (higher part of the range 25.25-29.5 GHz) noting the need to share the band with microwave links;
- 36-37.5 GHz and 39.5-40.5 GHz;
- 42.5-52.6 GHz (except 50.2-50.4 GHz);
- Possibly 55.78-66 GHz

This initial prioritisation results from the application of the criteria proposed in response to question 9. More precisely we propose some preliminary considerations for the bands that we propose to consider with lower priority:

- Range 5925-8500 MHz:
  - It is unlikely that the band 5925-6425 GHz, which has been rejected by CEPT for WRC-15, will be supported at WRC-19;
  - The use of the bands above 7.1 GHz, generally designated as 7/8 GHz bands, is poorly harmonised between CEPT countries (see ECC Report 173). Therefore the possibility for a global or even regional harmonisation of the band for IMT is likely very limited;
  - The band 6425-7100 MHz is also used for backhauling. Even if geographic discrimination might be possible, the band alone does not satisfy the 1 GHz contiguous band criterion.
- The 15 GHz and 18 GHz bands are identified in ECC Report 173 (figure 23) as bands which showed the highest positive FS growth between 1997 and 2010, which means that refarming for mob ile access would be expensive and technically difficult.
- Range 21.2-23.6 GHz: the bands 22-22.6 GHz and 23-23.6 GHz are extensively used for backhauling, and their refarming would be expensive; in addition the use of this range is generally subdivided into slots smaller than 1 GHz.
- Range 25.25-27 GHz: the band is used for backhauling up to 26.5 GHz.
- 36-40.5 GHz: the band 37.5-39.5 GHz is widely used for backhauling and identified in ECC Report 173 (figure 23) as a band which showed the highest positive FS growth between 1997 and 2010.

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.

Bands not considered in Question 10 should not be definitively excluded from the investigations. For instance, we propose to possibly consider also the following bands:

- 31.8-33.4 GHz, and
- 40.5-43.5 GHz.

These bands are also designated for fixed service and can be used for backhauling nevertheless this usage is presently rather limited and in these conditions co-existence between backhauling and access can be considered.

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

See response to question 10.

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?

Effective use of the band by the services / applications listed in the Tables of frequency allocations, as some services listed in the Radio Regulations may not be largely used, and potential for global harmonisation as resulting from the analysis of this effective use.

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

As presented in Questions 9 and 13, from our point-of-view the most important criteria for prioritizing bands are:

- The ability to cope with mobile operation requirements, taking into account technology evolutions (e.g. potential for the implementation of advanced antenna technologies) and requested performances;
- The potential for global or at least regional harmonisation;
- The ability to share the band with other services / applications, taking due account of the technical and operational characteristics of IMT applications and of implementation of mitigation techniques;
- The effective and planned uses of the bands by currently allocated services.

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