Consultation on the future management approach for the 70 / 80 GHz bands

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Introduction

Siklu Communication is pleased to submit our response to the "Consultation on the future management approach for the 70 / 80 GHz bands". Siklu is the market leader in E-band in terms of number of radios shipped globally in 2012 and 2013. Given this we have a lot of experience with regulations and the various regulatory bodies around the world. From this perspective, we witness time and again, Ofcom's unique foresight and remarkable process in the matter of E-band regulation. Ofcom is one of the first administrations to have opened up E-band, and to have done so in a way that facilitated and encouraged the UK public to gain access to his important band. Over the last few years, OFCOM has consistently been taking significant and proactive steps to involve stakeholders in its rule making, and improve the utility of the band. This has culminated in the present consultation. We note the high level of effort, understanding and thought that went into preparing this Consultation, and are grateful to Ofcom for facilitating E-band regulation in the UK in such a thoughtful and dedicated way.

Question 1: Do you have any additional information to provide to that presented in this Consultation that you believe Ofcom should consider? If so please provide clearly evidenced views. Are there any other issues that you believe Ofcom should have considered?

(a) Fee structure proposed for the fully-coordinated block

We would like to address the fee structure proposed for the fully-coordinated block, as shown in Clause 5.59 of the Consultation:

Channel Size	Pro-rated Interim Fee
<250MHz	£100
250MHz	£225
500MHz	£450

Ofcom correctly notes that at present, the typical channel bandwidths used in E-band are 500MHz and 250MHz. However, the vast majority of links currently deployed in the UK (>92%) occupy 500MHz or wider channels (as is shown in Figure 7 of the Consultation). These data support Siklu's view that in the near future, the majority of deployments in the fully-coordinated block will be 500MHz or more. In light of this, we find the proposed interim fee of £450 to be very high, and are concerned it would, in effect, limit the utility of the fully-coordinated block.

A fee of £450 is 9 times the current fee of £50, an order of magnitude more expensive.

Considering that there are currently hardly any deployments for mobile backhaul applications, as well as "… a significant degree of uncertainty regarding this demand in the medium to long term…" (Clause 5.37 in the Consultation), we believe such a high fee would be detrimental to mobile backhaul applications gaining foothold in the fully-coordinated block, and in fact push users to other (lower frequency) bands. Needless to say, this would be contrary to the whole point of this Consultation: providing the necessary certain and coordinated framework to encourage mobile backhaul use of E-band.

We are also concerned that existing licensees in the proposed fully-coordinated block would be heavily penalised by seeing their annual fee rise from £50 to £450.

Ofcom is planning to hold a Fixed Links Fee Review in the near future, and therefore the proposed fee of £450 is, by definition, temporary. Consequently, we propose that in the interim, Ofcom adopts a less severe rise in the license fee. This would serve to encourage mobile backhaul applicants in utilising the fully-coordinated block in E-band, and allow Ofcom more time to assess the impact of a license fee increase on the utility of the band.

(b) Precluding TDD from the proposed fully-coordinated Block

Ofcom is proposing to preclude TDD from the proposed fully-coordinated block, and instead allow FDD only. We believe this approach would lead to a highly inefficient spectrum usage, as is shown below. Allowing TDD, and therefore significantly better spectrum efficiency, is critical, particularly because the spectrum accessible to mobile operators under this proposal is limited to 2x2GHz.

Traditional well known sub 40GHz microwave systems were designed for the voice only era. During that era, the role of those links was mainly to backhaul voice. From a technical point of view, because spoken conversation is balanced, symmetrical transmission links were the obvious solution, and that led to adoption of dual channel, FDD based links. In recent years the amount of data being transmitted over mobile networks already surpasses voice. The data-centric nature of the internet has led to asymmetric backhauling needs. Today's networks statistics show upload-download ratios of 1:5 to 1:7. The continuous usage of symmetrical FDD links to backhaul such significantly asymmetric traffic, has led to a continuously growing non-optimal and inefficient utilization of the wireless backhaul frequencies.

The new backhaul networks designed for both higher capacities and asymmetric data deliveries leverage both FDD & TDD systems:

- TDD based systems are usually deployed for:
  - One hop to a fiber termination point
  - Non-redundant cascaded topologies of wireless backhaul links.
- FDD based systems are usually deployed for:
  - Ring topologies
  - Fiber backup solution for the metro fiber network

The common approach adopted by leading mobile operators and wholesale backhaul providers around the world for each duplex technology to be used:

- **Leverage the FDD E-band links for redundant wireless transmission sections:** Areas of the backhaul network were FDD transmission systems are required are mainly rings. The reasons to use rings are heavier traffic areas were additional redundancy is needed. E-band links are the optimal answer for heavy traffic. Since ring are by nature symmetrical, clearly FDD links are the suitable solution for long term investment.

- **Leverage the TDD E-band links for efficient spectrum usage:** While considering the significant asymmetric characteristic of mobile network traffic, the TDD technology supported by both American FCC and European CEPT standards for E-band links, was found by many operators as an optimal way to efficiently use single channel in typical mobile backhaul link. Figure 1 shows an example of live network cell-site traffic statistics where the actual upload-download ratio is 1:6:

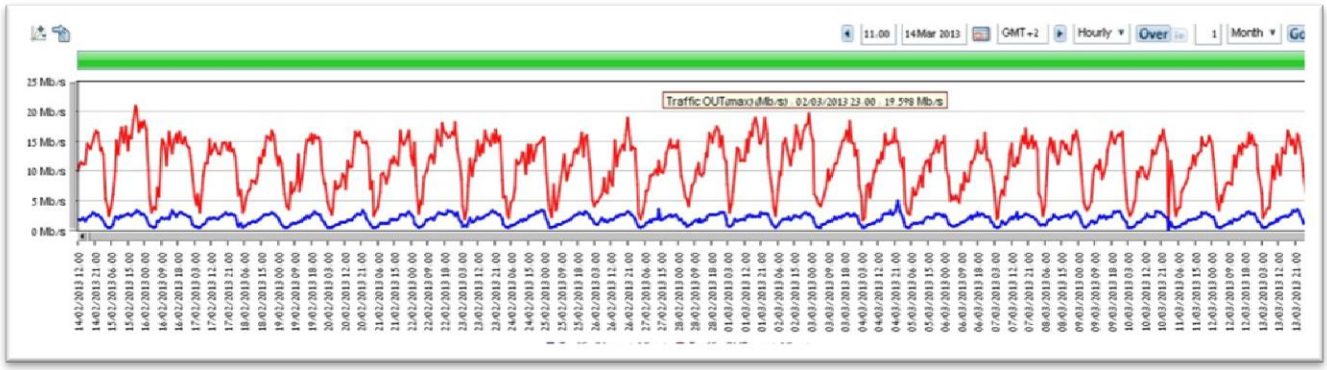

Figure 1: Typical 3G cell-site traffic*, red=download, blue=upload

*taken from real live commercial network

If we take this example and backhaul this site with a traditional FDD based transmission system, there will be a **~40% waste of spectrum**. This is illustrated in figure 2 for typical dual channel based backhaul link, under the following assumptions:

- 500MHz of spectrum is implemented in each direction
- Conservative upload-download ratio of 1:5 ratios
- As is shown in Figure 2, 400MHz of spectrum are essentially wasted by the FDD approach.

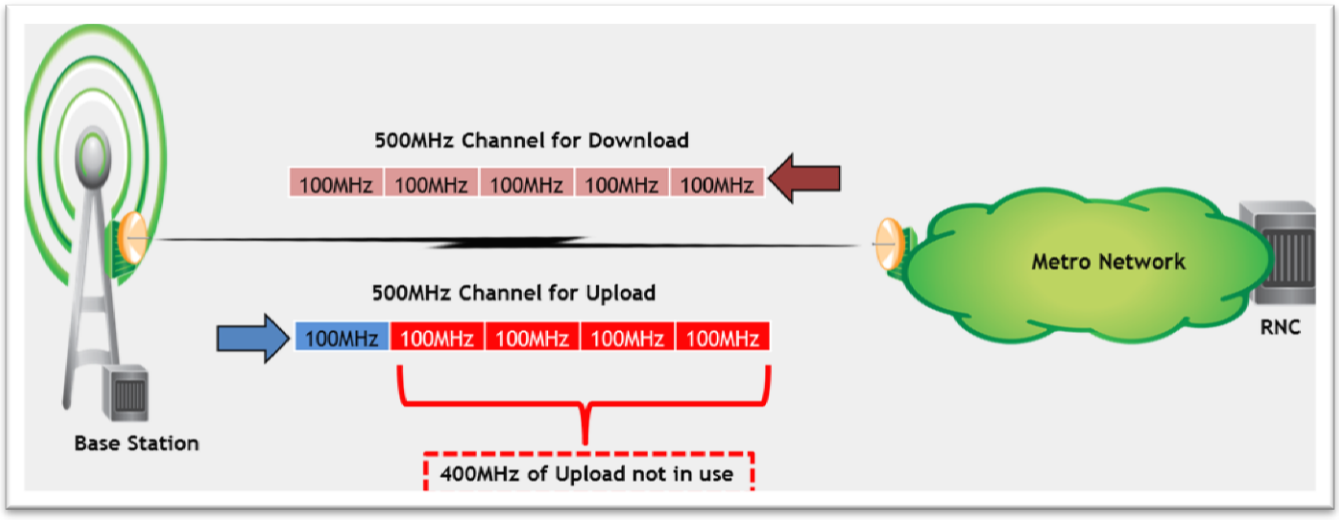

Figure 2: FDD backhaul channel utilization in a typical mobile backhaul link

The proposition that mobile backhaul has become highly asymmetric is widely shared in the industry, and is based on repeated findings and network statistics. Here are some additional supporting viewpoints:

- Ovum's research *Asymmetric traffic patterns in a 3G network* concluded: "The need for improved quality-of-experience technology to support video and gaming has driven the 3GPP to increase the asymmetric pattern of downlink vs. uplink in HSPA+ and LTE networks to ratios of 3:1 to 6:1". Ovum's findings are brought in figure 3:

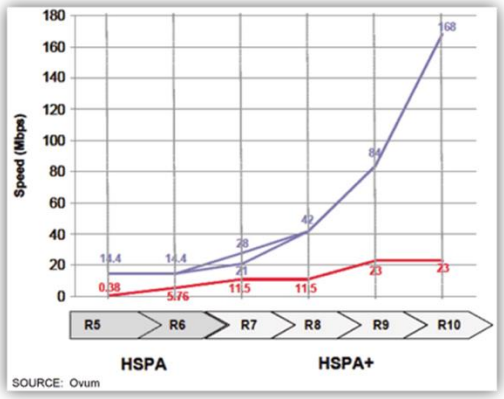

Figure 3: Download (blue) and Upload (red) speeds of the evolving mobile standards

- LTE UE categories in 3GPP R8:

Category		1	2	3	4	5
Peak rate Mbps	DL	10	50	100	150	300
	UL	5	25	50	50	75

Figure 4: Download and Upload speeds for various categories of LTE

- CEPT Spectrum Engineering (SE) 19 concluded the drives for TDD based modulation backhaul links:
  - Increased downlink capacity, accommodating the end user needs, while using the same amount of spectrum;
  - Increased spectral efficiency;
  - Installation of additional links in the remaining spectrum;
  - Increased number of serviced sites, if used a suitable channel arrangement

Based on the above, Siklu believes Ofcom would contribute to better spectrum efficiency and utilization by allowing both TDD and FDD in the fully-coordinated block. This would enable mobile operators to select them most spectrally-efficient duplex mode. We further believe this would lead to faster upgrades from old microwave backhaul to the more modern E-band systems, thus improving the networks and the end-customer service.

Siklu also proposes that in the upcoming Fixed Links Fee Review, subject to the better spectral efficiency provided by TDD in mobile backhaul applications, Ofcom considers differentiating the license fee between TDD and FDD links. In particular, the fee for TDD links should be 50% of the FDD fee, in order to reward and encourage those users who opt for greater frequency efficiency and provide others better access to the spectrum.

Question 2(a): Do you agree with our proposals to offer a mixed solution that allows stakeholders to choose between the currently available self-coordinated authorisation approach and a new Ofcom coordinated approach for the band?

Siklu agrees with this approach as reflected in the Consultation and believes it will serve the interests of both Mobile Service Providers and Enterprises. We believe this proposal will encourage competition while at the same time enable effective investments in the broadband infrastructure.

Question 2(b): Do you agree with the segmented band plan with the split of 2 x 2 GHz and 2 x 2.5 GHz for Ofcom coordinated and self-coordinated approaches respectively?

Siklu agrees with the proportion proposed in principle. However, as explained in our response to the next question (2c), we believe there is no need to keep a 250MHz guard band, and that this tranche of spectrum should be annexed to the self-coordinated block, creating a split of 2x 2GHz and 2 x 2.75 GHz.

Question 2(c): Is the guard band size of 250 MHz considered appropriate between the two approaches?

Guard bands are commonly used to separate different bands and minimize any inter-band interference. However, we believe the intra-band guard band proposed in the Consultation is not required, would constitute a waste valuable spectrum, and limit the utility of the E-band in the UK. Siklu is therefore proposing that the guard band be eliminated, and annexed to the self-coordinated block. That is:

- Coordinated block (2GHz): 71.125-73.125GHz / 81.125-83.125GHz
- Self-coordinated block (2.75GHz): 73.125-75.875GHz / 83.125-85.875GHz

Here are the reasons to support our proposal:

1. It is well known that transmission in E-band is highly directional. This is due to the short wavelength, as well as ETSI's requirement for a minimum antenna gain of 38dBi. These two factors together mean that the 3dB beam-width of any E-band transmission is less than 1°. Such narrow beams ("pencil beams") inherently mitigate any interference, by constituting a natural "*spatial* guard band". We therefore believe that the additional proposed *spectral* guard band will not, in practice, contribute noticeably to additional interference reduction.

2. Ofcom is correct in assessing that Enterprise applications currently dominate use of the band, and that mobile applications have not yet taken hold. For this reason, Ofcom has wisely proposed an uneven mixed-management approach, where the block allocated for self-coordination (2x2.5GHz), and which is more suitable for Enterprise applications, is larger than that allocated for full-coordination (2x2GHz). Furthermore, in light of the uncertainty in future mobile backhaul utilization of the spectrum, Ofcom is prudently suggesting (Clause 5.42 of the Consultation) that in assigning spectrum in the fully-coordinate block:

   > "The algorithm will be able to make assignments automatically within the first 1 GHz of spectrum; but it would require an active intervention by Ofcom, as the assignment manager, to open up the second tranche of 1 GHz within the assignment tool and so make the full 2 x 2 GHz available for assignment."

   This means that the second tranche of 1GHz (72.125-73.125GHz / 82.125-83.125GHz) will de-facto become a guard band of sorts. That is to say: until such time that fully-coordinated applications gain considerable foothold (if indeed they will), the adjacent second tranche of 1GHz is to remain unoccupied. Therefore Siklu believes that an additional tranche of unoccupied spectrum (73.125-73.250 GHz / 83.125-83.250 GHz), as in the proposed guard band, is superfluous and serves no practical purpose.

3. Ofcom is right in assessing that any self-coordinated spectrum, may easily be reassigned in the future to the fully-coordinated approach (Clause 5.42 of the Consultation):

   > "… it would be relatively straightforward (in implementation terms) to expand the proportion of the band allocated to the Ofcom coordinated approach whilst reducing the proportion of the band allocated to the self-coordinated approach. This is because, when making new assignments in the expanded Ofcom coordinated segment, we would be able to take account of self-coordinated links (that exist at the time the change was made)."

   Siklu suggests that Ofcom take a similar view with regards to the proposed guard band: let the proposed guard-band be annexed to the proposed self-coordinated block. In the future, if and when Ofcom finds it necessary to grant licenses in the second fully-coordinated tranche of 1GHz (72.125-73.125GHz / 82.125-83.125GHz), then at that time, any existing links in the proposed guard-band can be taken into consideration, and ensure no interference is caused to a newly licensed fully-coordinated link.

   In other words, there no reason to presently preclude Enterprise applications in the proposed guard band, where the proposed guard band can be easily and readily introduced at any time in the future, if and when the need arises.

4. Elsewhere in the Consultation, Ofcom is considering mandating the CEPT channel plan, ECC/REC/(05)07, for the self-coordinated block. Siklu supports this proposal as it will make self-coordination easier to perform. Ofcom additionally correctly notes that at present, the typical channel bandwidth is 500MHz.
   By introducing the guard band (excluding 2x250MHz of spectrum: 73.125-73.375 GHz / 73.125-73.375 GHz), and at the same time mandating the CEPT channel plan, Ofcom would be, in effect, limiting Enterprise access to the spectrum by an *additional unintended*

2x250MHz. This is because in the proposed self-coordinated block, Channel 5 in the 500MHz channelization plan (73.125-73.625 GHz / 73.125-73.625 GHz) will become unavailable. That is to say, users of the most typical channel bandwidth (500MHz), would be "penalised" by a loss of 500MHz, meaning 1 out of 9 available 500MHz channels.

In other words, the proposed guard band would defeat Ofcom's intention of an uneven mixed management approach, where the currently rife Enterprise applications have access to a larger block of spectrum than the as-yet non-existing mobile backhaul applications. This is because the guard band would in practice limit the fully-coordinated block to channels 1-4, and the self-coordinated block to channels 6-9 of the 500MHz channelization plan. This would de-facto create an *even* mixed management approach, contrary to Ofcom's objective. By eliminating the proposed guard band and annexing it to the self-coordinated block, Ofcom would allow Enterprise applications access to channel 5-9, which is in the spirit of the Consultation.

To summarize, Siklu believes the proposed guard band should be annexed to the self-coordinated block because:

- The "pencil beams" characterising E-band transmissions automatically create a "spatial" guard band, rendering unnecessary any additional spectral guard band.
- By limiting fully-coordinated licenses in the second 1GHz tranche, Ofcom already puts in place a 1GHz spectral guard band.
- Any self-coordinated licences occupying the proposed guard-band may be easily taken into consideration in the future, in order to protect newly-deployed links
- The 2x250MHz guard band would in effect deprive use of 2x500MHz of spectrum, in the most prevalent case of 500MHz channelization.

Question 3(a): For the Ofcom coordinated part of the band, do you agree with the proposal to make available channels of 500 MHz and 250 MHz (with smaller channels being made available when the standards are completed) and to make these channels available in up to 1 GHz bandwidth in the first instance?

Siklu agrees with the approach to allow channels of 250 MHz and 500 MHz up to 1 GHz bandwidth in the coordinated part of the band. Since our products introduction at 2011, Siklu's systems supports both 250 MHz and 500 MHz channels and those system are installed around the world as well as at the UK. As for the option for wider channel up to 1 GHz, we are closely watching the emerging standards and will probably introduce new generation of products that will utilize this wider channels option.

Question 3(b): Is there a requirement for channel sizes greater than 500 MHz in the coordinated block? Please submit evidence to support your view.

The proposed coordinated block contains only 2GHz at lower band (70GHz) and additional 2GHz at the higher band (80GHz). As this block was correctly identified as the future solution of mobile backhaul networks, it should be carefully allocated while keeping in mind the need to support constantly increasing number of links in any given area. Mobile service operators and backhaul wholesale providers around the world are finding the millimetre wave technology based systems, to be the optimal answer for long term investment while being driven to upgrade their microwave backhaul links. Most current and future systems claim to support 500MHz and even lower channels. Allowing further usage of old, inefficient higher spectrum consuming systems will waste valuable channels resources while narrowing the options for additional systems to be deployed at a given area.

Question 4(a): Are there any aspects of the current self-coordinated licensing and link registration process that could benefit from improvements? Please provide specific information and reasons for how your suggestions would improve the process.

Like Ofcom, Siklu believes the public would benefit from better utilization of E-band. One way to do this is to make self-coordination easier, by automating the light-license application process. We therefore recommend Ofcom considers implementing an automated system, similar perhaps to the American approach, which eases the Channel and Polarization selection for any newly planned link: the online system enables easier channel and polarization selection by taking into consideration the current installed base with its above parameters and also TX power and antenna gain. Applicants enter its preferred parameters and the online system calculates the mutual interferences and gives a feedback about it. The feedback has several levels. Based on those levels the applicant may decide to continue with his chosen parameters or to try other ones in order to improve interference results.

For more information on the FCC's methodology, here is the link to one of FCC's approved sites for the registration process: http://mmradioforms.com/mmRadioForms/FrontPage.aspx

Question 4(b): Should Ofcom consider mandating the CEPT channel plan, ECC/REC/(05)07 for the self-coordinated block? Explain clearly the reasons to support your view.

As mentioned at the answer to 2(c), Siklu supports this proposal because It will make self-coordination easier to perform:

1. The radio links are normally developed, tested, and manufactured based on the standards that mandate pre-defined channel based frequency selection, and it is unlikely that vendors would deliver non channel plan based systems.
2. Most software based tools for frequency selection that are based on calculating mutual potential interference with install base, are using CEPT channel plan.
3. Enabling frequency selection that is not subject to pre-defined channel arrangement is perhaps analogous to allowing cars on a motorway to drive without constraints of lanes. The lanes on a motorway are the basic means taken to ensure maximum car-flow with minimal chances for accidents. Similarly, allowing a radio to operate at a random frequency, would increase the probability of harming existing links, and/or block future adding of links around this frequency.

Question 4(c): Are the technical parameters shown on the register sufficient to enable self-coordination? Should Ofcom consider presenting additional parameters on the register? If so, which parameters and why?

Polarization is the only parameter Siklu found missing at the current register of the self-coordinated links. It is well know that polarization enables re-use of the same frequency (channel) even over the same path without mutual interferences, thus adding the installed links polarization enables more options to select from while planning a new link for installation.

About Siklu

Siklu builds low-cost Gigabit wireless backhaul solutions operating in the 60, 70 & 80 GHz millimeter wave bands. Uniquely based on an all-silicon design that reduces price and increases reliability, the field proven systems are a top choice of operators for mobile backhaul and small cell backhaul, as well as business service delivery. Leading global millimeter wave deployments, thousands of Siklu EtherHaul radios have been installed and are operating solidly under all weather conditions.

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