Your response

Question 1: Do you agree with our proposed approach towards registered fixed link and satellite earth stations users of the 3.6GHz to 3.8GHz band?	Yes, in principle, but we believe that if Ofcom adopted a "high spectrum efficiency approach" in its planning of this band rather than the "traditional approach" (more suited to lower spectrum bands), it would deliver considerably more for citizens and consumers and, at the same time, provide more certainty to Earth Station owners being asked to re-site their Earth Stations outside of urban areas. Our case is set out in the attachment below:

Question 2: Do you have any comments on our assessment of the likely costs and benefits of our proposed approach?	The consultation document appears to be suggesting a traditional route in planning for the 5G future, impacting the treatment of incumbent services. This is likely to lead to exceedingly low geographic spectrum efficiency, perhaps as low as 10%. The traditional approach is "national". However, if Ofcom defines what it means by the term "5G" in the context of this specific 5G pioneer band, the defining characteristic will turn out to be "dense small cell networks". The coverage of such networks will never be national, will take 10-12 years to roll out over most UK Cities and towns and coverage will be ultimately confined within urban areas and indoors. We set out in our full response below some principles that can deliver a much higher geographic spectrum efficiency (pack more services in), lower costs and deliver considerably more benefits to citizens, consumers and businesses. A headline summary of our main points are: 1. Ofcom needs to translate the term "5G" into the specific context of the 3.6-3.8 GHz band 2. A geographic split in the spectrum management approach is needed between urban areas (with a very strong 5G centric small cell approach) and the rest of the UK. 3. The entire 5G pioneer band 3.4-3.8 GHz needs to be planned as a whole 4. Ofcom should integrate into their approach a second layer of spectrum exploitation that maximises "opportunistic use". 5. Ofcom should ease the competition rules for the band 3.4-3.8 GHz to facilitate voluntary spectrum pooling and small cell (RAN) sharing Items 4 & 5 aim to facilitate the emergence of the wide RF channels (>100 MHz) essential to the success of 5G. Our case is set out in the attachment below:

Attachment to the summary set out in the above form

Contribution from the University of Surrey 5G Innovation Centre

Ofcom Public Consultation - Improving consumer access to mobile services at 3.6 GHz to 3.8 GHz

Introduction

The 5G Innovation Centre (5GIC) at the University of Surrey is the largest academic research centre in Europe dedicated to the development of 5G and the next generation of mobile and wireless communications. Bringing together leading academic expertise and key industry partners in a shared vision, the 5GIC is helping to define and develop the 5G infrastructure that will underpin the way we communicate, work and live our everyday lives in the future.

A number of our members will no doubt be making their own responses and this contribution is not intended to represent their views or a collective view. The purpose of this contribution is to point out the special nature of the 3.6-3.8 GHz band in any national 5G implementation and how this can inform Ofcom's approach to the planning of this 5G pioneer band, including the treatment of incumbent services, as set out in this Consultation.

Comments on the Consultation Document

We support the principle of the Ofcom proposals; however, the consultation document appears to be suggesting a traditional route and the use of traditional tools in planning for the 5G future, impacting the treatment of incumbent services. This is likely to lead to exceedingly low geographic spectrum efficiency outcome, perhaps even as low as 10%. Ofcom would need to take a far more innovative approach for higher bands, such as 3.6-3.8 GHz, if it is to fulfil its duties to make efficient use of this valuable spectrum band. We believe that Ofcom should adopt a "high spectrum efficiency approach" rather than the "traditional approach" (more suited to lower spectrum bands) in its planning for this band. This has the potential to deliver considerably more for citizens and consumers. We set out below our proposals for Ofcom's consideration:

1. We believe Ofcom will have a much clearer idea of the spectrum sharing potential of 5G with incumbent services and, at the same time, see how to maximise the benefits of 5G, if it translates the term "5G" into the specific context of the 3.4-3.8 GHz band. We understand the context to be the provision of contiguous coverage (both outdoors and indoors) of enhanced Mobile Broadband (eMBB) over urban areas. The objective is to deliver a significant leap in urban *mobile* capacity and data speed

(Gb/s) and a significant reduction in latency through the deployment of dense small cell clusters and the exploitation of RF channel widths of greater than 100 MHz. (See section (a) and (b) in the background supporting information below).

2. The Ofcom Executive Summary Section 1.20 says: *The effect of our proposed approach would be to enable future mobile services in the 3.6GHz to 3.8GHz band to be deployed in many areas from around 2020, but not necessarily nationwide before 2022.* The use by Ofcom of the term "nationwide" is significant. The 5G dense small cell networks intended for this 5G pioneer band will never be "nationwide" and, in fact, they may never extend much beyond 10% of the UK landmass (see section (c) background information below). We believe more efficient use would be made of the spectrum by a geographic split in Ofcom's spectrum management approach between urban areas (with a very strong 5G centric approach around dense small cell networks) and the rest of the country, where more flexible approaches could be taken, including secondary licensing. On this basis Ofcom could give far more certainly now about the risk of harmful interference to earth station owners being asked to relocate their earth stations out of urban areas, as well as providing a massive lift in the geographic spectrum efficiency of the band in the longer term.

3. Whilst it is understandable that the sub bands 3.4-3.6 GHz and 3.6-3.8 GHz are being handled by Ofcom separately, there needs to be an over-arching policy if the benefits of 5G to citizens and consumers is to be maximised. For example, *it is not efficient to mix macrocells and microcells in the same spectrum band*. Our suggestion is that the sub-band 3.4-3.6 GHz should accommodate 5G macro-cells where they are needed and the sub band 3.6-3.8 GHz, including the sub-band 3605MHz to 3689MHz, should be specifically for dense small-cell deployments in urban areas. We hope in your consultations with the band owner of the sub-band 3605MHz to 3689MHz, they might be sympathetic to such a rationalisation. This would offer the prospect of a full 200 MHz being utilised in the most efficient way and would maximise the data capacity yield for the entire market.

4. It is likely to take the best part of 10—12 years to cover entire cities and towns (including suburbia) with dense small cell networks. Even then there are likely to be many pockets in urban and suburban area with no dense small cell coverage. Thus, both inside and outside of urban areas there will huge scope for "opportunistic" use of this valuable spectrum band on a non-interference basis. Ofcom should therefore integrate into their approach a second layer of spectrum exploitation that allows "opportunistic use", including indoor use, to be maximised over the entire 3.4-3.8 GHz band. This route would open up the possibility to exploit the full 400 MHz for wide RF channels and enable millions more citizens and consumers to enjoy amazingly high performance 5G connectivity outside the coverage of 5G public dense small networks.

5. Ofcom should consider relaxing the infrastructure competition rules for the band 3.4-3.8 GHz to give industry the maximum flexibility for spectrum pooling and sharing 5G small cells (RAN sharing) on a voluntary commercial basis. This holds out a brighter prospect of the full 400 MHz being used for 5G dense small cell networks in urban areas. Otherwise we cannot see how Ofcom intends to meet the 5G objective of RF channel widths of greater than 100 MHz in this spectrum range. (Such a relaxation could also help to drive down the cost of covering UK's urban areas with a high performing 5G dense small cell infrastructure by at least 50%).

Background Supporting Information

(a) 3.6-3.8 GHz is key to providing urban *mobile* Gb/s coverage

The band 3.4-3.8 GHz is critical to prevent the creation of a new digital divide between the huge data rates (~10 Gb/s) at 5G hot spots delivered using the 5G pioneer band at 26 GHz and the near universal rates that will only be in the 10's of Mb/s delivered by the new band at 700 MHz. The geographic coverage of the 5G hot spots may not extend much beyond 1% of the UK by geography. The 3.4-3.8 GHz band has the technical and economic characteristics to increase the geographic mobile coverage of Gb/s data mobile speeds by up to an order of magnitude more. It is this combination of "mobility", enhanced capacity, high data speeds and low latency that will deliver a transformative experience for citizens and consumers and businesses. It is where the UK's urban wireless infrastructure needs to be ten years from now for the UK to remain globally competitive.

(b) The Term "5G" needs translating into a technology neutral spectrum engineering description

The term "5G" has to be translated into more technology neutral spectrum engineering terms. Taking the trial deployment at the 5G IC as a working hypothesis, the particular element of 5G infrastructure intended for deployment in this band would have the following typical characteristics.:

Characteristic	Defining description
Extent of coverage	Urban (less than 10% of the UK surface area)
RF Channel Bandwidth	Greater than 100 MHz
Base station antenna height	Low. As a reference, lamp posts are typically 6-10 m structures
Transmission range	Typically under 250m
Deployment	Outdoor dense small cell clusters and indoors (homes and places of work)
Cost of indoor equipment	Consumer type price levels
Service type	Mobile, Nomadic

Cell data speeds	Low 1's of Gb/s
Multiple Access	TDD

(c) The 5G pioneer band 3.4-3.8 GHz is only intended for urban use

- There has never been an intention for dense small cell networks to cover more than urban areas. An extensive mapping by the UK National Ecosystem Assessment (NEA) produced the following data:

Region	Urban Landscape
England	10.6%
Scotland	1.9%
Wales	3.6%
N Ireland	4.1%
UK overall	6.8%

This is the likely geographic extent of 5G coverage by means of public dense small cell clusters in the band 3.4-3.8 GHz.

(d) 5G needs very wide channel bandwidths

The die is already cast on how the band 3.4-3.6 GHz is to be allocated and with what conditions of use. How the 3.6-3.8 GHz band is made available to the market will therefore critically determine whether the potential 5G impact of 3.4-3.8 GHz can be realised in the UK. Regulatory means by which wide channels of at least 100 MHz can be made available is the most pressing issue not properly addressed in Ofcom's comments to date.

(e) The potential contribution of small indoor cells

A particular challenge for 5G eMBB will be within building coverage in the band 3.4-3.8 GHz. There is a strong case for lightly licensing two 100 MHz channels in the range 3.4-3.8 GHz for low power indoor cells. We believe this to be technically feasible. Indoor cells could contribute 3000- 4000 sq km of 5G urban coverage over time and relieve the need to provide dense small cell deployments in suburban areas of exceptionally low footfall.

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