



The UK Wireless Internet Service Providers Association

# Notice of proposal to make regulations in connection with the award of 2.3 GHz and 3.4 GHz spectrum

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Version: 1

**Abstract** — UKWISPA profoundly disagrees with auctioning the 3.4 to 3.8 GHz band nationally. The bidders are likely to be the mobile operators and they will not use the spectrum outside city centres, shopping malls, stadia and stations. The spectrum is ideal for Fixed Wireless Access and Ofcom are ignoring the new WISP need for this band and the public good by helping rural broadband delivery. Suggestions are made for major or small changes to the auction in order to accommodate the changed circumstance of the population of the UK.

## Contents

1	Author Note .....	2
2	Introduction .....	2
3	New Information .....	3
4	Key points presented at the previous consultation .....	4
5	The Auction .....	5
5.1	New proposal — To auction the high density areas now .....	5
6	The Questions .....	5
7	Annex A - Cambium response to the previous consultation .....	7
8	Annex B - Cambium annex to the previous consultation .....	15

# 1 Author Note

The author is employed by Cambium Networks as CTO. At this consultation he has been elected as spokesman for UKWISPA for regulatory matters. He now responds to this consultation in that capacity. He uses much of the material from the previous consultation to help make the points for this consultation.

# 2 Introduction

Change in the technological arena is happening faster than ever before and it is important that our regulators keep up with the pace of this change. The scene today is so different from the situation at the beginning of this process and Ofcom may have ignored the changes that have occurred. It is important for Ofcom to embrace the changes that have taken place in the Wireless Internet Service Provider (WISP) industry and provide the means for the WISPs to further deliver high quality broadband to greater numbers of subscribers.

At the beginning of the process in November 2013 WISPs probably had 10 thousand subscribers and a coverage of 100 thousand. During the consultation process the numbers have multiplied by 10 and are growing by 100% per annum, also the speeds delivered have moved from 10 Mbps to superfast and are expected to be ultrafast by the time the operators deliver 5G. In the same way that mobile operators need more spectrum to deliver innovative services so do the WISPs. In order to deliver ultrafast services in a contiguous area WISPs will require 160 MHz of licensed spectrum. At the beginning of the process WISPs did not have an industry body to speak for them. Today, there are about 120 WISPs in the UK and many are members of UKWISPA or INCA. WISPs are expanding at a fast enough rate that BT cannot discourage them as happened in the past<sup>1</sup>. WISPs have also been assisted by many millions of pounds of direct or indirect funding by the government through BDUK.

UKWISPA recognises that it is coming to this party late but while many are making use of government assistance in their build processes they are surprised to learn that the regulator is not listening to their needs. The 3.4 to 3.8 GHz spectrum is recommended in Europe for the use of Fixed, Nomadic and Mobile services. In this auction Ofcom are ignoring the Fixed and Nomadic uses. The mobile operators who have the funds to buy the spectrum do not have the funds to deliver 5G mobile to rural areas using this spectrum. By contrast, WISPs can make excellent use of this spectrum to provide superfast and ultrafast broadband to these rural communities. The technical reasons for these assertions are stated in section 4.

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<sup>1</sup> On many occasions BT have supplied service to villages immediately after a WISP has started service in the same village.

The points being made in this consultation are not new but were made in the previous consultation and are provided as an annex to this response. The pace of change is such that there is new information to be shared in section 3.

As stated in previous consultations on these bands UKWISPA profoundly disagrees with the method of auction of the 3.4 GHz band. In the previous consultation Cambium stated that this is not in the interest of the rural consumer and in this report for convenience we restate the previous reasoning and add further reasoning gathered in the intervening period.

Ofcom have publicly ignored the Cambium input to the previous consultation and even refused to talk about it at an INCA meeting with Ofcom on 7th March 2017. I managed to speak to one person in Ofcom on 29th June and the response to Cambium's proposals were that the proposals were too late. In the light of this I have offered a new proposal to modify the auction which would be simpler to implement and give flexibility to respond to future information. It is very important that Ofcom are able to respond to the very fast changes that take place in technology and public needs.

The world is in the process of fast change. At the beginning of Ofcom's process in 2013 there was no WISP industry of note. In the UK now the WISP industry covers more than 1 million properties and delivers service to more than 100 thousand. It would be unfortunate if the assistance by one government department (BDUK) to reduce the digital divide was then thwarted by Ofcom.

Ofcom are committed to deliver this auction to the benefit of the UK but consumers will not be able to buy 5G product until 2020<sup>2</sup>. At that point we will expect WISPs to have connected more than 500 thousand and covered more than 3 million properties. Thus they will be a significant community.

We are fully in support of mobile 5G and expect companies such as Cambium, Infinet, Radwin and others to use the technology to deliver FWA service in other countries using the 3.4 GHz spectrum, but the auction as proposed will help 85% of the country at the expense of the other 15%.

### 3 New Information

There is new information to be considered which was not available to us at the previous consultation.

1. Ofcom have stated that they believe that mobile 5G will be delivered to the large percentage of rural communities using the 3.4 to 3.8 GHz bands.<sup>3</sup>

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<sup>2</sup> 3GPP specifications for 5G are expected in mid 1999.

<sup>3</sup> Stated by Cristina Data of Ofcom in her presentation at an INCA conference on 12th July 2017.

2. Ofcom have stated that 3.4 to 3.8 GHz is identified at a European level as suitable for 5G services<sup>4</sup>.

Item 1 does not appear to stand up to technical scrutiny and consequently business sense<sup>5</sup>. Item 2 misses the point that 3.4 to 3.8 GHz is clearly suitable and desirable for city centres, shopping malls, stations and stadia. However, the band is unsuitable for the wide coverage required for rural areas. Item 2 also misses the point that at this European level the spectrum is identified for Mobile, *Nomadic and Fixed*.

3. The MNOs are operating 4G in 800, 900, 1800, 2100 and 2600 bands. A small survey of 4G sites in rural areas shows that, not surprisingly, one of the lower bands is normally chosen for rural operation.
4. For the MNOs to use this band for 5G in rural to cover the same as current 4G they will have to increase the basestation numbers by a factor of 4 to 8 which is improbable.
5. OpenSignal provide data for 4G coverage. The frequency is unspecified. It shows that along roads the coverage in rural areas is variable and usually has drop outs along any particular road and very few villages have coverage.
6. WISPs are now delivering broadband service (usually superfast) to more than 100 thousand subscribers and the number covered<sup>6</sup> by the WISP service is more than 1 million<sup>7</sup>.

If you followed the input from Cambium to the previous consultation you will realise that none of items 3-6 above is surprising. The higher frequencies do not penetrate trees, diffract around hills or enter houses as easily as the lower frequencies. These factors are less important to WISPs because they can deliver service to the high points on properties, also low cost in band relays can provide service efficiently to valleys and normally difficult to reach properties.

## 4 Key points presented at the previous consultation

Key considerations for the usability of the 3.4 to 3.8 GHz band for mobile and fixed are reproduced from the previous consultation in the document on pages 10 and 11. These facts and opinions were presented on July 12th at an INCA conference which Ofcom attended and the facts were not disputed.

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<sup>4</sup> In a letter to Mel Stride MP directed to Nigel King dated 26th July 2017.

<sup>5</sup> Reasons given in Section 4 “The Missed Opportunity” of Cambium’s submission to the previous consultation gives the detailed technical reasons.

<sup>6</sup> By covered we mean that no more infrastructure is required to provide service.

<sup>7</sup> One of the top 5 operators covers 1/4 million subscribers.

A possible consideration for the antenna gain of mobiles (point 2) is that dynamic beam forming could be made available increasing the antenna gain from -8 dBi to perhaps zero dBi. The gain is unlikely to be increased beyond zero dBi because of the mobile platform size.

As you can see from these arguments and the new information in section 3, mobile operators are unlikely to use the 3.4 to 3.8 GHz band in rural areas and WISPs have an increasingly urgent need to be able to use this spectrum to increase the coverage of superfast broadband and make ultrafast broadband available to households.

## 5 The Auction

Section 8 of this document presented a possible method of defining a geographic auction allowing the operator to choose where he expected to deliver service. Ofcom clearly feels that this approach is too complicated to implement in the time available.

### 5.1 New proposal — To auction the high density areas now

The imperative for mobile 5G is to have access to the large percentage of the population in the 3.4 to 3.8 GHz band. The housing density could be analysed in a simple manner and the highest 85% could be auctioned without risk. This will obviously include the big cities and enable operators to:

- have confidence in the viability of licenses,
- enable trials and operation of the technology in the areas where it most likely to be used, and
- Keep the UK ahead of other countries in the 5G race.

Density can be determined using the Ordnance Survey property data.

Ofcom can after this auction decide the best use of the spectrum in rural areas with the support of proper studies comparing mobile use of 3.4 GHz with WISP use of the band.

## 6 The Questions

**Question 1** *Do you have any comments on the changes we are proposing to the draft Regulations, as summarised in paragraph 2.5 and described in detail in this Notice?*

Apply the auction to the higher density housing areas because the method suggested at the previous consultation was too complicated to be incorporated in time.

**Question 2** *Do you have any other comments on the drafting of the proposed draft Regulations?*

Take the opportunity to define the 85% highest density areas and auction those. Study further the use of the 3.4 GHz spectrum in rural areas. In this way Ofcom can make a better decision about the use of the spectrum in rural areas and avoid deepening the digital divide.

## 7 Annex A - Cambium response to the previous consultation

A notable change is that now WISPs have deployed 3000 sectors of 14 × 14 MUMIMO 5 GHz system in various markets. This technology is important to 5G mobile since it significantly increases capacity. Note that it has little effect on range, a requirement for the use of 3.4 to 3.8 GHz in rural.

## Cambium Networks

# Notice of Ofcom's proposal to make regulations in connection with the award of 2.3 GHz and 3.4 GHz spectrum

N. J. R. King

January 30, 2017

Ref: PHN-4412/NJRK

Version: 1

**Abstract** — This paper highlights the need for Ofcom to consider the auction for 3.4 GHz to apply to cities, town centres, and places of public focus such as stadia, stations and out of town shopping centres. Ofcom should retain rural areas for licensing WISPs.

## Contents

1	Introduction	1	3	The need for 3.4 to 3.8 GHz for mobile.	3
2	Background to the need for 3.4 to 3.8 GHz for business and residential broadband in the rural economy	2	4	The missed opportunity	5
			5	Conclusion	7
2.1	The need for this band in rural broadband delivery	3	6	References	7

## 1 Introduction

Cambium Networks welcomes the opportunity to respond to the consultation on the auction of 2.3 and 3.4 GHz spectrum. We will restrict our comments to 3.4 GHz since that is where we have most knowledge.

Spectrum is a valuable national commodity and it is Ofcom's responsibility to enable the best use of that commodity. It is also necessary for Ofcom to help to implement government policy where possible. In this case government is trying to implement a policy of Broadband for all through BDUK but this consultation fails to help



BDUK by omitting any reference to the WISP industry. (See presentation from Chris Townsend to UKWISPA 18th January 2017)

We believe that an auction in the manner proposed leaves a huge missed opportunity. We believe that the spectrum should be enabled for dual use, with the same frequencies being used by mobile operators and fixed operators in separated localities. (See section 4)

The auction is being pushed forward to enable manufacturers and operators of 5G systems to know that this spectrum will be available to them. It is noted that, product is not yet available for use in this band. Unfortunately, uncertainty concerning spectrum availability will delay the availability of product. Thus, we do not wish to delay the auction unnecessarily, we merely wish to propose that the licensing conditions are modified to align with the applications and use cases which the mobile operator will actually want and use. This spectrum is unlikely to be usable for rural mobile operation and so should not be licensed for that purpose. The opportunity is to divide areas of the country into high and low density. Ofcom should restrict the mobile operator to areas of high density and retain the low density areas for rural broadband. The supply of licenses for rural broadband can be left to another consultation although this is much more urgent than the mobile requirement.

Ofcom will note that Cambium responded to the consultation “Improving consumer access to mobile services at 3.6 to 3.8 GHz” and that all of the comments made in that response also apply to the 3.4 to 3.6 GHz band.

## 2 Background to the need for 3.4 to 3.8 GHz for business and residential broadband in the rural economy

After attending a meeting with Ofcom on 26 January 2016, it became obvious that Ofcom do not realise that the only way to deliver on government policy to provide access to broadband for the 4 million people who do not currently have access is to provide that access predominately by wireless.

Unfortunately a study by Analysys Mason commissioned by Ofcom and delivered in November 2016 titled “Estimating the cost of a broadband Universal Service Obligation” incorrectly dismisses FWA as a contender for part of this. It did it by not considering the various technologies (FTTC, FTTP, FWA, Satellite) as complementary to one another each having its own niche. It is clear that FWA can delivery superfast speeds efficiently and the coverage of Dartmoor and Exmoor is testament to that fact. Occasionally there will, for instance, be a need to use satellite when other alternatives are not able to reach the premises.

3.4 to 3.8 GHz is an ideal frequency for delivering the majority quantity of FWA for broadband. As described there is a relatively large spectrum available at high power. Currently most FWA is provided by 5.8 GHz where there are restrictions on power, the need to abide by DFS requirements, and to observe the notch for RTTT. These restrictions lead to there only being one useable 40 MHz channel available in the 5.8 GHz band. They also lead to restrictions in range and the ability to penetrate lines of trees. Tree penetration is easier at 3.5 than 5.8 GHz and the increased power increases the probability of penetration.

The fact that there is only one 40 MHz channel means that there is no opportunity to use separate channels to give frequency reuse. There seems to be an urban myth that LTE can deliver three times the capacity by using the same spectrum three times on a three sector cell site. This is simply untrue. If the sectors are being used simultaneously then there is interference from one sector to another. This interference reduces the capacity from three times to approximately one and a half times. In addition this is shared capacity where the Erlang effect may cause an overall reduction in efficiency which offsets the 50% increase in capacity.

## 2.1 The need for this band in rural broadband delivery

It might be argued that FWA is providing a useful service in the 5.8 GHz band despite the restrictions mentioned above. Unfortunately, the operators are delivering on the need to provide coverage of the 4 million people on the basis that only 30% or so will take up the service in the first year. The expected take up of superfast will increase substantially in the second and third years partly because of the consumers extricating themselves from existing contracts and partly because of more services being available. This parliamentary briefing dated Aug 2016<sup>1</sup> gives an insight from BDUK on the take up rate of the new superfast services. There is a danger of failure if the 3.4 to 3.8 GHz band is not provided to rural service providers on favourable terms.

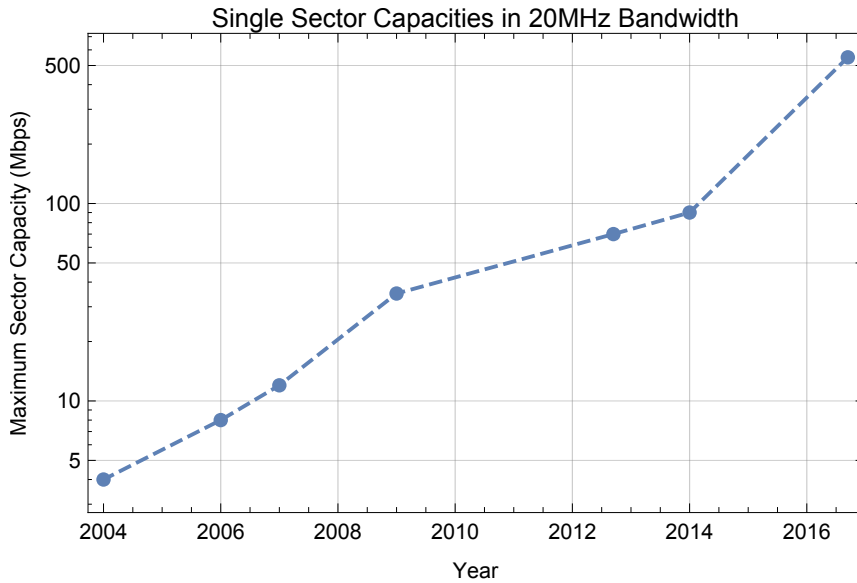
## 3 The need for 3.4 to 3.8 GHz for mobile.

The mobile operators do not need this spectrum now. Unlike the FWA industry the mobile industry is very well funded and consequently able to lobby for more and more spectrum. Ofcom need to look carefully to understand whether and when this is really required. The FWA industry has had to apply the most advanced wireless innovations to enable broadband delivery in the small bandwidths available. In particular, Cambium and Mimosa are delivering MUMIMO solutions which increase

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<sup>1</sup> <http://researchbriefings.files.parliament.uk/documents/SN06643/SN06643.pdf>

capacity in the spectrum available by factors of greater than three. Cambium’s 14×14 solution is being used on about 100 FWA cell sites in USA and Italy with deployments in many other countries almost immediately. The number of FWA cell sites increase every day since the product launch in September 2016. Figure 1 shows how Cambium have been increasing this sector capacity in 20 MHz over 12 years.



**Figure 1** Cambium downstream capacities available in 20 MHz bandwidth by year.

By contrast, the mobile devices through 4G have been able to receive MUMIMO signals but the infrastructure has not provided MUMIMO. If mobile really needed the spectrum then they would have already deployed LTE advanced. As it is, to my knowledge there are no MUMIMO mobile basestations in use globally. Indeed there does not appear to be a plan to deploy LTE advanced until 2020. It seems illogical to bow to the demands of the mobile industry for more spectrum until the current spectrum is used efficiently.

FWA needs this spectrum today and if it was provided today it would be used with only a few months lead time since FWA product is available for use in this band from many companies. The band is available for FWA access in many countries.

It has been stated in a letter to me from Sharon White that 5G *could* solve the rural broadband problem. Unfortunately “could” is not good enough for the rural community who need superfast broadband today. The government requires farmers to prepare their returns on line. Many businesses have to have an online presence

in order to compete. BDUK are commissioned to deliver the capability to 2 million new people by the end of this year. 5G will likely not become a reality for 10 years. I have not found a definitive use case for mobile use of this band. It is likely only to be necessary for city high streets, stadia and stations.

## 4 The missed opportunity

As explained previously the 3.4 GHz band and the adjacent 3.6 GHz band are ideal for the purpose of Fixed Wireless Access in rural areas. The bands also have use for increasing mobile bandwidth in town centres, railway stations and stadia. These two applications are inclusive rather than exclusive and can be allowed to coexist. The consultation document does not recognise the need for both uses to be enabled. There is no provision for geographic licensing.

The lost opportunity is that mobile operators will only want the spectrum for use in the high density environment. Propagation for mobile is very different than for fixed. Simply put:

1. mobile antennas are typically 1.5 m above ground,
2. mobile antennas have -8 to -5 dBi gain,
3. coverage is required everywhere in the coverage space,

Whereas:

- A. fixed antennas have gains of 18 to 25dBi,
- B. fixed antennas can be deployed at 7-15 m above ground, and
- C. fixed antennas can be placed in the best location without requiring to provide large individual coverage space.

The consequence is that:

- a. mobile technology is very unlikely to be used in rural areas at 3.4 GHz,
- b. mobile technology will be used in areas where public density is high and will consequently need more spectrum,
- c. fixed technology is uncompetitive in urban environments because cable, fibre to the cabinet and fibre to the home is not as expensive to deploy and generally gives higher speeds.
- d. recent deployments in the UK (Dartmoor and Exmoor as an example) have shown how effective using fixed wireless to deliver broadband to villages, farms and small businesses can be.

The mobile operator has a very different business from the fixed wireless broadband operator. Mobile is well established and requires national coverage of service. In

order to provide ubiquitous coverage they will deploy the spectrum most suitable for long range coverage in rural and use all the frequencies available to them in urban to get the required throughputs. Sometimes the urban deployment will require the use of these higher frequencies of 3.4 GHz in order to provide larger bandwidths to the target coverage area.

Fixed wireless is not so well established but has received interest from government because it can provide broadband coverage to rural communities. The fixed wireless operator is normally focussed on out of town areas where there is little competition from other technologies. Operators tend to be focussed on very small areas of a few villages up to regional areas. There are no national operators (although there is a national license holder).

It has been acknowledged that the rural FWA operator is essential to provide the final 5-10% of broadband service in the UK<sup>2</sup>. The evidence is in the provision of subsidies from BDUK to enable the broadband service to be provided in rural areas. The government is promoting the digital economy and, for example, now require that farmers make returns on-line. Service is sometimes provided by the mobile infrastructure using EE's 4G service. This is the exception rather than the rule, and while data rates can be high the subscriber cost can be prohibitive for large data quantities. FWA technology is designed for higher speed and higher quantity access which is enabled through the use of high gain antennas on houses.

The only spectrum available to WISPs (excluding UK Broadband) for longer range deployment is at 5 GHz. There are two bands (which have different regulations) available;

- one is at 30 dBm EIRP 5.470 to 5715 MHz (the 5.4 band), and
- the other is at 5715 to 5795 and 5815 to 5850 using 36dBm EIRP (the 5.8 band).

The 5.4 band is only really suitable for in-village distribution because of the low power while the 5.8 band provides Line-of-Sight ranges of about 5 km. The 5.8 band is difficult to use efficiently because of the split nature. There are only  $4 \times 20$  MHz channels or  $1 \times 40$  MHz channel. Since the 5.8 band is lightly licensed it can be subject to interference, as can the 5.4 band. Both bands are subject to intermittent service since the 5 GHz user has to make way for radar when present.

The opening of 3.4 and 3.6 GHz band to Fixed Wireless Access for broadband would transform the businesses. I anticipate that an EIRP of 40 to 50 dBm would be allowed and this would enable excellent coverage into very rural areas. As an example

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<sup>2</sup> <http://ukwispa.org/wp-content/uploads/2017/01/Chris-Townsend-UKWISPA-18-January-2017-slides.pptx>

it is likely that Dartmoor and Exmoor could have been covered with a substantial reduction in the number of masts than were actually required.

## 5 Conclusion

The WISP industry in the UK have made exceptional use of the 5 GHz bands to deliver service to 20,000 subscribers or more, it now urgently needs access to the 3.5 GHz bands in order to flourish and deliver to the remaining 4 million subscribers.

It seems that Ofcom considers that the ability to pay for spectrum is a good indicator of the usefulness of that spectrum for a particular application. That might be an unreliable indicator in some circumstances.

The government apparently believes that broadband is useful in rural communities, and is unwilling to leave provision of that service entirely to market forces, to the extent that operators are presently supported in bringing broadband to rural subscribers. It makes more sense to consider the total cost to taxpayers to provide broadband access in areas where fibre and copper do not presently reach. Revenue for spectrum auctions should be considered together with the cost of subsidising universal service.

## 6 References

- Presentation to UKWISPA by Chris Townsend of UKBD<sup>3</sup>
- Report on Universal service from Analysys Mason<sup>4</sup>

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<sup>3</sup> <http://ukwispa.org/wp-content/uploads/2017/01/Chris-Townsend-UKWISPA-18-January-2017-slides.pptx>

<sup>4</sup> [https://www.ofcom.org.uk/\\_\\_\\_data/assets/pdf\\_file/0027/95580/annex6.pdf](https://www.ofcom.org.uk/___data/assets/pdf_file/0027/95580/annex6.pdf)

## 8 Annex B - Cambium annex to the previous consultation

In this annex Cambium described a simple method for extending the consultation to enable the auction to be geographic.

## Cambium Networks

# A Simple and Efficient 5G 3.5 GHz Auction Method that enables 100 Mbps Rural Broadband

N. J. R. King

March 2, 2017

Ref: PHN-4441/NJRK

Version: 0.4

**Abstract** — A method of auctioning the 3.5 GHz bands is presented which would enable Fixed Wireless Access to use the spectrum in rural areas without interfering with the 5G requirements for the mobile companies.

Version	Date	Change	Author
0.4	2017-03-02	Many changes after reviews.	Nigel King

## Contents

1	Introduction	1	4	Some calculations	3
2	Background	2	5	Conclusion	4
3	The principle of auctioning spectrum geographically	3			

## 1 Introduction

This document presents a simple method of ensuring that the mobile companies only buy 5G 3.5 GHz licenses for the area that they really need. The mobile companies are unlikely to require use outside cities, malls, stadia and stations and so in rural this spectrum can be used to provide broadband by fixed wireless access. The delivery of superfast and faster broadband can be provided by equipment available today. This idea meets the aspirations of the government to achieve broadband for all, and also enables Ofcom to meet their mandate to ensure efficient spectrum use.



In the consultations “Improving consumer access to mobile services at 3.6 to 3.8 GHz”<sup>1</sup>, and “Award of the 2.3 and 3.4 GHz spectrum bands. Competition issues and auction regulations”<sup>2</sup>, Cambium Networks suggested that the 3.5 GHz spectrum should be reserved for rural broadband delivery to properties outside cities, shopping malls and stadia. The responses did not propose a method for achieving this. Here we propose a simple method of valuing and auctioning spectrum in different areas.

## 2 Background

As has been stated in the consultations for 3.6 to 3.8 GHz and the 2.3 and 3.4 GHz auctions, auctioning national licences is a very inefficient method of distributing this spectrum. There are two potential users of the spectrum, the mobile providers and WISPs. The mobile providers in areas of dense population including stadia, stations, shopping malls and high streets will be using low height antennas ( $\approx 6$  m above ground) because the signals can not travel very far to the mobile users at this frequency. WISPs can make very efficient use of these frequencies, in areas which are of no interest to the mobile operator.

Currently, WISPs are providing broadband service to rural properties under difficult circumstances of both anti-competitive practises and limited spectrum. Countries that have less difficult circumstances (USA, Italy etc.) have a thriving WISP industry. The only spectrum which most WISPs have available is in the 5 GHz bands. In practice the main spectrum is the 5.8 GHz portion of the 5 GHz band because of the slightly higher power available than in the 5.4 GHz portion. Unfortunately, the 5.8 GHz portion is badly restricted by RTTT and slightly affected by DFS. The availability of 3.4 to 3.8 GHz to improve the delivery of rural broadband is an opportunity that should not be missed. Higher power and lower frequency will increase the efficiency of WISP deployments by a factor of 2 to 10 where I define efficiency as the number of base sites required per unit area.

The efficiency is increased dramatically by:

- the availability of spectrum at higher power enabling longer range communication to cover larger areas at lower cost, and
- the availability of wider bandwidths (than are available at 5.8 GHz) increases the throughput raising the probability of delivering more than 100 Mbps to rural properties.

How is Ofcom to enable the geographic licensing of these bands without considerable effort on Ofcom’s part? A simple solution is to be found in the next section.

<sup>1</sup> [https://www.ofcom.org.uk/\\_\\_data/assets/pdf\\_file/0035/96893/Cambium-Networks.pdf](https://www.ofcom.org.uk/__data/assets/pdf_file/0035/96893/Cambium-Networks.pdf)

<sup>2</sup> <https://www.ofcom.org.uk/consultations-and-statements/category-1/award-of-the-spectrum-bands>

### 3 The principle of auctioning spectrum geographically

The country can be divided into 1 km squares using the ordnance survey grid (such as SX7660). The mobile auction would be performed with each company bidding for each square and also the amount of spectrum required in each. Ofcom would put a reserve on each square for each 10 MHz of spectrum of say £1000. This would ensure that the mobile companies only bid for the area they require. Competition in high value properties will push the auction price in many places higher than this.

They may decide to purchase additional squares in order to ensure that there is no interference from the expected rural WISPs in the less likely condition of using high site base stations. There seems to be agreement that the mobile companies are very unlikely to want this spectrum in rural areas since the propagation to mobiles will be very poor.

Currently a number of Fixed Wireless operators receive subsidy under the BDUK rural programme, either through local authority procurements or through voucher schemes. These subsidies are very effective at increasing the availability of super-fast broadband services in challenging areas. As we reach the final few percent of premises currently unable to get superfast - and in some cases basic - broadband services, the role of FWA operators likely to increase significantly. Delivering these services using 3.5GHz spectrum will significantly improve performance thus making BDUK subsidies more cost-effective, offering better value for money to the public purse.

An obvious deployment constraint for the rural operator is to ensure that PMP links do not cross the mobile/rural boundary. Since narrow beam antennas ( $<20^\circ$ ) are normally used for the Customer Premises Equipment (CPE) the mobile bidder can then compute the number of squares needed for his network to be interference free.

### 4 Some calculations

There are 242,000 square km in the UK<sup>3</sup>. About 7% can be considered urban<sup>4</sup> (17,000 sq. km). A current expectation of license cost might be  $\approx$ £1bn for 100 MHz of spectrum. The likely number of squares which the mobile operators may want is less than 17k. An average price is likely to be  $\frac{\text{£}10^9}{17\text{k}} = \text{£}58\text{k}$  per 100 MHz or  $\approx$ £6k per 10 MHz per sq. km. Ofcom need to judge a reserve price which would ensure that the mobile operator really wanted to operate in or near the 1 km being requested. My suggestion would be  $\approx$ £1000 per 10 MHz per sq. km.

<sup>3</sup> [https://en.wikipedia.org/wiki/United\\_Kingdom](https://en.wikipedia.org/wiki/United_Kingdom)

<sup>4</sup> <http://uknea.unep-wcmc.org/LinkClick.aspx?fileticket=u60Ugtegc28%3d&tabid=82>

## 5 Conclusion

A very simple method has been presented that enables dual licensing of the 3.4 to 3.8 GHz spectrum to mobile and rural WISPs. The method enables Ofcom to meet its charter of utilising spectrum in the most efficient manner possible and also enable the delivery of superfast to the whole country. This opportunity cannot be lost to the nation.