Urban WiMAX response to Ofcom's Spectrum Commons Classes for licence exemption consultation

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Urban WiMAX welcomes the opportunity to respond to this consultation on Spectrum Commons Classes for licence exemption. We support the principles expressed in this consultation with respect to traditional licence exempt devices and technologies being able to share the same frequency bands.

Urban WiMAX would like to raise some important issues for consideration with regard to using WiMAX technology within a spectrum commons class approach. We operate a Fixed Wireless Access (FWA) network for business broadband services in the 5 GHz band. The business model is to deliver high quality reliable broadband services using carrier grade point to multipoint equipment.

The lightly-licensed and unlicensed bands are an important proving-ground for economically-important new wireless technologies and business models worldwide. There is sufficient spectrum at 5GHz (360MHz in bands B and C) to allow many technologies with differing characteristics to co-exist across the spectrum range, even in areas of high usage. At this time there is no alternative spectrum available for use by technologies that adopt a co-ordination approach to sharing rather than a polite interference-avoidance approach. However, a co-ordination approach to sharing makes much more efficient use of spectrum resources than the polite approach. This is particularly true in the early days of spectrum commons availability, in which technologies that use the polite interference-avoidance approach are designed to be deployed by those with no knowledge of RF and can be expected to operate in one or two default channels leaving large parts of the range unused.

Urban WiMAX and others, using the lightly-licensed and unlicensed 5GHz spectrum here and in other countries, are proving that there is a market need for a new broadband service which has different characteristics to the fixed broadband services and, in particular, is physically separated from the fixed broadband services that in most cases share the same physical infrastructure. This is true both for smaller businesses that cannot afford the cost of physically-separated routing and for the smaller players in the UK finance industry which have recognized the need for separation in Best Practice guidelines issued by the FSA. Having physically-separated telecommunications circuits allows business to rely on network-based services for mission-critical applications, increasing their ability to respond to varying economic conditions and reducing costs. However, the value of broadband services like Urban WiMAX's to end-users is very dependent upon the ability of whatever technology is deployed to support Quality of Service, which is in turn dependent upon the requirements imposed by sharing within the band.

We appreciate allocation of spectrum cannot be made on a technology specific basis but instead use the current regulatory framework to improve spectrum management techniques. The Urban WiMAX network can be considered as a wide bandwidth, high capacity operation in relation to spectrum commons classes and therefore demands a reasonable slice of the spectrum to offer its services.

WiMAX technology ensures efficient use of the spectrum by adopting OFDM methods of spectrum access. It uses the spectrum in an optimal way thereby embracing the approach described by the Strategic Framework Review (SFR) strategy for spectrum management.

The Urban WiMAX business continues to grow based on the use of an emerging technology and we would like to see regulations which support the development of these new, innovative

technologies. The remainder of this response provides Urban WiMAX's views with regard to WiMAX and its inclusion in this consultation.

Q1: Do you agree that the spectrum commons class of a technology should be based on its interference characteristics?

Urban WiMAX agrees with the principle that spectrum commons class of a technology should be based on its interference characteristics, by grouping different technologies without bias being placed upon a specific application. However, the interference characteristics must be generic enough to be inclusive of technologies that were not originally designed to operate in a licence exempt band but can adapt due to the advancements in technology development.

WiMAX has the ability to adjust its technical parameters to ensure it uses the spectrum resource effectively by avoiding interference. Therefore, it is not solely the interference characteristics that would be dependent upon defining a technology's spectrum commons class.

Urban WiMAX suggest that as new technologies emerge and interference properties become more considerate to other users, Ofcom should investigate the different interference characteristics further. This means that Ofcom is able to include other interference properties and make a more informed judgement on how a technology is classed within the spectrum commons framework.

Q2: Do you think that the ratio of channel bandwidth to the width of the band is a good representation of the use of the frequency domain resource and the interference potential of a technology in this domain?

Urban WiMAX agrees this ratio is a fair representation based on relevant technical parameters in order to ascertain the amount of spectrum used by a particular technology.

In order to determine the interference potential of a technology in the frequency domain consideration must be given to how much the interferer technology occupies the shared band. This factor can significantly alter the outcome of the interference indicator in a number of ways. One particular impact is intermodulation between two systems. Intermodulation products occur when two differing frequencies multiply and generate a new interfering frequency in the same band. This would be a frequent occurrence for a WiMAX network sharing with a lot of other licence exempt users.

In a shared band where multiple bandwidths can potentially be deployed the systems vary quite dramatically from 10 kHz for non-specific short range devices up to 2169 MHz for WPAN at 60 GHz. It would be reasonable to suggest some systems will not physically be able to share with other technologies. This is due to the large differences in bandwidth which can cause interfering effects such as blocking or overloading the receiver.

In the case of FWA networks the interference bandwidth would in most cases be less than the bandwidth of the victim bandwidth which places the network at a disadvantage. This is due to the victim bandwidth having more difficulty to find a new frequency given its wideband nature and also due to the gradual increase in spectrum occupancy.

The WiMAX standard supports a number of different channel bandwidths (5 MHz, 10 MHz and 20 MHz) to make the best use of the available spectrum. The implication of using the ratio, as proposed, does not take account of the technology's flexibility of supporting a number of different bandwidths. Therefore, Urban WiMAX would like this factor taken into consideration.

Q3: Do you think that the duty cycle is a good representation of the use of the time domain resource and the interference potential of a technology in this domain? Do you agree that the duty cycle should be evaluated at the busy hour?

Urban WiMAX consider the duty cycle ratio the most appropriate method to determine the interference potential for the time domain. However, the duty cycle for a FWA system needs to be considered for the scenario in which Urban WiMAX uses this spectrum.

Defining the duty cycle as a victim receiving continuously ensures the worst case scenario for the interfering technology. In this way FWA networks often operate utilising a 100% duty cycle with maximum throughput. The nature of operation would prove sharing the channel to be very difficult with another non-WiMAX technology since the established link will likely be occupied the majority of the time.

A FWA network operates on a master/slave basis which means the duty cycle between the base station and the subscriber station is disproportionate e.g. 3:1 downlink to uplink ratio. Further, the 802.16d standard has the option for using TDD as the channel access mechanism and therefore the downlink traffic and uplink traffic are on the same channel. Therefore the duty cycle factor should take into account the uplink and downlink traffic and the type of application in use. The application the Urban WiMAX network offers is broadband access with a requirement to meet high demand for businesses which means the spectrum is in use constantly.

Urban WiMAX suggest that Ofcom further consider the duty cycle parameter for a FWA. To aid in the calculation process for a duty cycle of a FWA system, Urban WiMAX would assist Ofcom in providing typical last mile broadband traffic flow statistics for a small/medium enterprise, which can be used as the scenario metric.

In addition, we consider that the evaluation of the duty cycle at the busy hour is a practical measure for a random environment. However, the busy period for a WiMAX network can often be 24 hours a day 7 days a week depending on the type of application.

Q4: Do you think that the interference coverage plus the density of transmitters give a good representation of the use of the space resource and the interference potential of a technology in this domain?

Urban WiMAX consider the space resource method as a fair way of quantifying the scenario location of the licence exempt devices, where, the geographic domain does not refer to the location of the devices since they can operate in any location. However, this is not the case in a light licensed scheme, where the location of the transmitters are known and fixed with a defined coverage area which is generally much larger than that of a comparative licence exempt device.

The geographical density of transmitters in a light licensed scheme will be low compared to those for WiFi and Bluetooth in any given area. In a more coordinated scheme such as FWA networks there will be a known deployment of a small number of transceivers. The transceivers are the multipoint subscriber stations with a main controlling base station in a given area where the network has to cope with varying channel conditions. These channel conditions include multipath fading, varying propagation paths and other interfering effects. Therefore, the difference in spatial characteristics does not represent a level playing field. As a result the performance of the FWA network as a whole would be reduced.

It is also worth noting that the coverage area is dependent on the antenna gain and beamwidth. Some emerging technologies and standards employ multiple antennas in their network. Multiple antennas are defined in standards such as 802.11n and 802.16d where MIMO can be used as a technique to improve spectral efficiency or indeed range through beam forming. The parameter

for the coverage area should also be able to take account of technologies using multiple antennas.

Urban WiMAX recommend that light-licensed systems such as WiMAX are considered further when looking at the space domain and parameters such as MIMO are considered in any related calculations.

Q5: Do you agree with our method to calculate the interference coverage area of a transmitter? What is your view on a threshold level of -80 dBm/MHz to determine the interference range? Do you think the threshold level should be expressed as power density (dBm/MHz) or as power (dBm)?

Urban WiMAX agrees with the method in principle for calculating the interference coverage area of a transmitter for a spectrum commons approach. However, this method does not apply to FWA networks.

The method for calculating the interference coverage of a FWA transmitter is different to that for a spectrum commons approach. In the latter case it is necessary to incorporate the relevant parameters which have been considered in this consultation to calculate the interference. However, for FWA networks for example it is possible to have multiple antennas such as MIMO. Therefore, calculating the coverage area of a transmitter becomes more complex than in this consultation document. For example, the method for calculating the interference coverage area in a FWA environment would introduce characteristics such as quality of service, link budgets and multi-path fading with the aim of setting optimum levels to ensure sufficient resource thereby allocating capacity to the appropriate receivers.

The 802.16d standard incorporates features that demonstrate useful mitigation techniques to avoid causing interference. An example of this is where the equipment is able to scan the environment for known sensitive signals operating in the vicinity and take appropriate action to avoid them. This suggests that WiMAX was designed to ensure best efforts are made to not cause interference with non-WiMAX technologies in the same band.

Therefore, standard WiMAX features such as Orthogonal Frequency Division Multiplexing and Dynamic Frequency Selection (DFS) are not able to fit into the current proposed method for calculating the interference coverage area.

The threshold level of -80dBm/MHz is considered to be a sound starting point for licence exempt-devices. FWA equipment operate at sensitivity levels around this figure under normal operating conditions. Exceeding the threshold level of -80dBm/MHz will impact upon FWA networks quality of service and thus reduce the spectrum efficiency. It would be anticipated that deployment of a FWA network under the spectrum commons class approach based on the -80dBm/MHz threshold level would render most FWA networks unusable.

Due to the mixture of different bandwidths that could be present in the band, which can cause interference it would be more representative to use power spectral density in dBm/MHz as the threshold level.

Based on the advances in technology development that WiMAX offers and the different geographical environment in which a FWA network is deployed compared to licence exempt devices, UW recommend that the different technology parameters and deployment scenarios of WiMAX are taken into account when assessing the interference coverage area and threshold levels.

Q6: Do you agree with using a busy yet realistic scenario to derive the transmitter density of a technology?

Urban WiMAX supports the approach of using a busy yet realistic scenario to derive the transmitter density of a technology. However, further scenarios need to be developed incorporating highly utilised light–licensed WiMAX networks against different densities of licence exempt devices.

Urban WiMAX believe that a scenario of a light licensed or FWA network is different to that of a licence exempt scenario. A busy scenario of licence exempt devices is classified by having a high concentration of devices per unit area. The difference in a light licensed network is that it would include fewer devices if taken in the same unit area. For example in a dense urban area, there could be 3500 transmitters in $1km^2$ for a FWA network in comparison to 350,000 different Bluetooth devices in the same area. This suggests there is an imbalance in densities between licence exempt and light licensed networks. Therefore a busy scenario would only be representative of like devices in the case of FWA networks since the network is based on light licensing. However, a busy yet realistic scenario with licence exempt devices operating in a band with light licensed devices would demonstrate the hole punching effect of a deployed network.

Q7: Do you agree with the Interference Indicator being a product of the frequency domain factor, the time domain factor, the interference coverage area and the transmitter density?

In principle Urban WiMAX agree that the Interference indicator should determine the interference potential of a technology. The interference indicator incorporates the necessary parameters to calculate the interference potential of licence exempt technology devices. However, the interference indicator as proposed does not apply to FWA networks.

A straightforward product calculation of the parameters aims to achieve a result for the interference indicator within a given range e.g. 0-1. The aim therefore is to ensure the technologies that cause the most interference have a product calculation greater than 1.

Given the above factors WiMAX technology falls into the high interference class. However, it is not reasonable to compare WiMAX and other licence-exempt technologies to determine the interference indicator due to the vast differences in the use of the technology. The reasons for this are as follows:

- The comparison is not like for like. WiMAX is a different technology with different standards and approach to access spectrum with a network architecture design of all IP incorporating interference mitigation techniques.
- The Spectrum Commons Class framework is limited to licence exempt technologies which are based on their short range applications
- There is a limitation to the number of interference factors considered that do not take into account technologies such as WiMAX. For example, a FWA network employing WiMAX requires a coordinated approach to interference coverage due to the required longer range between transmitters and receivers, the mixed propagation paths and increased potential of interference at both ends of the network.

Urban WiMAX suggest there should be more inclusive contributing factors that will form inputs to the interference indicator.

Q8: Do you think that three classes of spectrum commons is the right number? What is your view on the proposed boundary values for the three classes?

Urban WiMAX believes that three classes of spectrum commons is the right number.

Given a broad analysis of the interference indicator, the resulting indicator for WiMAX would be far to the right of the high interference class value. However, the inclusion of the WiMAX technology with other licence exempt technologies is not appropriate as per our response in Question 7.

A technology that does not share the resource very well by virtue of its operation will be classified in a high interference potential class. The choice of boundary values must ensure the appropriate technology is classified correctly based on all the contributing factors of the interference indicator. Therefore, we recommend that WiMAX falls into a lower interference class since it employs good mitigation techniques to avoid interference and that it is able share frequency bands with similar technologies.

There is insufficient information to comment on the proposed boundary values. UW believes that more investigation would be required to establish better boundary values of licence exempt applications. For example applications including, Radio Microphones, Wireless Audio Applications and Wireless video cameras – Non Broadcasting should be included and the different scenarios associated which each application investigated further.

Q9: Do you agree with our definition of fairness and that all systems should be required to behave in a fair manner?

We agree with Ofcom's definition of fairness but this is still open to interpretation. Therefore a clearer definition of fairness with some examples may be more helpful.

At present WiMAX technology is able to behave in a fair manner based on the IEEE802.16d standard features. Therefore, Urban WiMAX believes that WiMAX technology should be classified as a fair technology. In future as technology progresses there will be a requirement for systems to behave in a fair manner. However, the use of a fairness policy should be dependent on whether the type of spectrum band would make effective use of such a policy. For example it is clear that for WiMAX, in a licence exempt scheme, would be difficult for a system to behave in a fair manner according to Ofcom's definition.

Q10: What is your opinion on the effectiveness of blind detection sensing techniques compared to signal specific techniques?

We agree with Ofcom's opinion that blind detection sensing techniques would be less effective than signal specific techniques because they make better use of the resources.

Urban WiMAX believes that for effective access to the spectrum, signal specific techniques would be a better choice. This is due to systems having some knowledge of each other when trying to access the spectrum at the same time. For example, WiFi uses a Frequency Hopping technique to ensure a certain level of access to the spectrum is provided to users based on signal specific detection. In the case of WiMAX it is standard for deployed networks to detect certain signals and avoid them by applying the relevant techniques.

Q11: Do you agree with the proposed polite rules?

Urban WiMAX agrees the proposed polite rules offer a framework for licence exempt technologies to behave in a polite way when and where appropriate. The polite rules offer a mechanism for technologies of high interference class to share the resource fairly. This is

applicable when it is not essential for the device to require access to the resource for particular periods of time.

WiMAX is able to support the polite rules **in its own way**, for example a standard feature of WiMAX is Dynamic Frequency Selection (DFS). It can scan the spectrum on a periodic basis for signals that are considered to be interfering signals. The mitigation is for the transmitter to search for an available frequency and inform the network to move to that frequency.

Manufacturers have developed their own equipment in accordance with IEEE802.16d which supports features such as DFS. In doing so demonstrates the ability to be a polite technology.

Urban WiMAX believes coordination is the most applicable rule for the use of FWA networks. A method for sharing resources by making use of a light licensing scheme benefits users and sharers. The benefits of coordination would not impose further technical constraints since systems are planned to cooperate with each other in the same frequency band. Further, coordination enables full use of the resource in a spectrally efficient way. Urban WiMAX supports the use of a coordination approach as a polite rule.

However, the WiMAX standard cannot demonstrate good use of some of the other polite rules, because of the type of application it supports. For example a FWA network operates on a 24/7 basis with high demand for resources from its users. As a result cooperating with licence-exempt users will be very difficult. In addition, a reduction in availability of the resources (by adopting the proposed polite rules), creates a lower quality of service which would have a critical impact on the business.

Any polite rule that requires the FWA system to adopt further mitigation measures in order to share spectrum is not supported by Urban WiMAX.