**Issue 1**

BT's response to Ofcom's consultation on:

# The future role of spectrum sharing for mobile and wireless data services

Licensed sharing, Wi-Fi, and dynamic spectrum access

*(Issued by Ofcom on 9 August 2013)*

## 1. SUMMARY

BT welcomes Ofcom's consultation on the topic of spectrum sharing for mobile and wireless data services. With increasing pressure on available spectrum in the UK, including the massive growth in demand for mobile broadband connectivity, we applaud moves by Ofcom towards implementing greater and more sophisticated spectrum sharing.

Licensed spectrum, with the guaranteed quality of service that this can support, will continue to be extremely important in the future. However, we see shared access to spectrum as complementary and additionally providing other advantages, for instance access to very wide bandwidths with low barriers to market entry.

More efficient use of the scarce spectrum resources is possible in a modern spectrum management environment by embracing new techniques, such as dynamic access to spectrum using geolocation databases of spectrum availability. We support Ofcom's efforts to provide leadership in this area.

We note the extensive scope of the consultation and have broken down our summary response into the same three divisions used by Ofcom:

**The future role of Wi-Fi in helping to meet the demand for wireless data services:**

BT operates more than five million hotspots across the UK and Ireland, and millions of our BT Broadband customers have private Wi-Fi networks at home or in their businesses using BT hubs. As much as 80% of smartphone data traffic is carried over Wi-Fi[1]. Superfast broadband speeds of up to 80Mbit/s available on fixed networks enable consumers to use higher bandwidth applications. We see an inevitable demand for wider bandwidth channels for Wi-Fi in the future. Identification of new spectrum at 5GHz for Wi-Fi would provide contiguous spectrum to support multiple higher bandwidth channels, and would be particularly useful for transmitting data at high speeds between devices on a local basis.

As data volume demands on mobile broadband networks increase, operators will offload more and more data onto Wi-Fi networks where they can, including outdoor public hotspots, thus use of Wi-Fi outdoors will also remain important for the foreseeable future. We note that outdoor connectivity goes hand in hand with indoor connectivity, as services increasingly require session and service handover between all contiguous locations as well as between technologies.

**Increasing spectrum supply and better managing its use:**

Controlled access to spectrum using a geolocation database system is proposed by Ofcom for the TV white space spectrum, increasing spectrum efficiency. Over time Dynamic spectrum Access (DSA) may also have a role in some other bands, and may include spectrum sensing as well as geolocation databases. The licensing regime will be band specific, depending on the incumbent services, level of access envisaged and the particular type of shared access offered. For TVWS devices licence exemption is a pragmatic approach. For other bands a concept such as Licensed Shared Access (LSA) may be appropriate. The efficacy of any shared access scheme (including in the TV bands) could be increased by providing for spectrum management of the active devices within a technology, so that deployment parameters such as power and channel

[1] Quotient Associates, Technologies and approaches for meeting the demand for wireless data using licence exempt spectrum to 2022, http://stakeholders.ofcom.org.uk/market-data-research/other/technology-research/2013/demand-wireless/

could be varied based on the knowledge of the other devices requesting and using the spectrum at any one time.

**Supporting innovation through short-term access to shared spectrum:**

BT welcomes any moves to speed up and simplify the mechanisms for Ofcom granting access to spectrum for test and development reasons. Changes should be subject to appropriate confidentiality measures as well as various safeguards, for instance to avoid possible 'spectrum hoarding' situations and to prevent unintentional (or deliberate) blocking of access to test spectrum. An electronic online application process would be beneficial.

## 2. RESPONSES TO THE SPECIFIC CONSULTATION QUESTIONS

**The future role of Wi-Fi in helping to meet the demand for wireless data services**

*Question 1: How is demand for indoor wireless data connection speeds and capacity likely to develop over the next 5–10 years?*

BT provided its views on the demand for wireless services in response to the recent Ofcom call for input on Future demand for mobile broadband spectrum and consideration of potential candidate bands. In that response we highlighted the importance of Wi-Fi for consumers. Within homes fixed broadband is mostly consumed and shared via Wi-Fi. In most cases Wi-Fi is the mobile broadband data connection of choice within the home, given the available connection speeds and costs, and provides a much-needed offload path for struggling wide area mobile networks. Existing licence-exempt Wi-Fi using shared spectrum at 2.4GHz and 5GHz provides sufficient capacity at present and additional use of licenced spectrum for small cells within homes and offices can provide further improved coverage and enhanced quality of service. However current fixed network superfast broadband speeds of up to 80Mbit/s (and possibly higher in some cases and in the future) will enable higher bandwidth applications on home or enterprise networks backhauled by broadband, and applications are arising for high bandwidth data communications where both devices are in the same home or office. These developments point to an inevitable demand for wider bandwidth channels for Wi-Fi in the future.

Most mobile data is consumed inside buildings. The proportion of this traffic that is offloaded to small cells connected to fixed broadband networks (Wi-Fi or 3G/4G technologies) substantially impacts the amount of licensed spectrum that is needed to serve consumers who are outdoors or located beyond the coverage of small cells or Wi-Fi access points connected to fixed broadband networks. Consumers may prefer to connect to small cells or Wi-Fi access points, backhauled by fixed broadband, if speeds are higher or more consistent than those available on wide area mobile networks. Also, mobile operators may prefer to see in-building traffic off-loaded to fixed networks to preserve available spectrum resources for users located away from buildings and small cells.

There is evidence that most Smartphone data is consumed inside the home and most of that data is consumed over Wi-Fi rather than the public mobile network. For example, Analysys Mason reported research in 2012 revealing that in Western Europe at the end of 2011 an estimated 75% of Smartphone traffic was consumed within the home or office, and of this 77% was carried over Wi-Fi on the fixed broadband network connection[2]. The Quotient report annexed by Ofcom to this consultation refers to 80% of UK mobile phone data traffic being carried over Wi-Fi[3]. These are higher percentages than quoted by Ofcom in their main consultation reference to a Cisco report (Ofcom's footnote 24), but we agree that all studies show the percentage of traffic carried by Wi-Fi instead of mobile broadband is high and increasing over time.

In the timescales of interest to Ofcom, the Government target of superfast broadband available to c. 90% of UK households is likely to have been achieved or exceeded. Given the available speeds and

[2] See Slide 4 of "LTE strategies and the challenge of mobile data growth", Analysis Mason, October 2012. http://www.analysysmason.com/PageFiles/35474/Analysys_Mason_LTE_strategies_Oct2012.pdf

[3] Quotient Associates, Technologies and approaches for meeting the demand for wireless data using licence exempt spectrum to 2022, http://stakeholders.ofcom.org.uk/market-data-research/other/technology-research/2013/demand-wireless/

current take up and pricing for fibre broadband it seems highly likely that the current trend of increasing off-load from mobile networks to fixed networks when using mobile devices in buildings will continue. The proportion of indoor traffic carried over licensed spectrum compared to licence-exempt spectrum will mostly be a matter for individual operator policy.

*Question 2: Will an extension of the 5 GHz band be required if Wi-Fi is to play a sustainable role in meeting the growing demand for indoor wireless connectivity?*

Wi-Fi operating in the 2.4GHz band can provide better coverage than 5GHz per cell, but with fewer channels available (and numerous other applications in the band) may have a greater risk of congestion/interference. Availability of more 5GHz spectrum would be useful in some circumstances in the medium to long term, addressing such capacity and interference issues. Moreover additional 5GHz Wi-Fi channels could achieve a large block of contiguous spectrum that could support multiple 20MHz channels that the latest Wi-Fi standards can utilise. Identification of new spectrum at 5GHz for Wi-Fi seems a sensible approach if coexistence studies demonstrate that sharing is feasible, for instance with radiolocation services in 5350-5470MHz and the fixed satellite service in 5850-5925MHz. Possible new systems also need to be considered in the sharing studies, such as DA2GC systems at 5855-5875MHz (currently under study in CEPT).

In principle we are supportive of allowing additional spectrum uses that do not impact on existing services, since this improves overall spectrum efficiency and the generated benefits to consumers.

*Question 3: Are there other types of indoor wireless applications [that] will require access to alternative spectrum other than that provided by the licence exempt 2.4 and 5 GHz bands used by Wi-Fi?*

Wi-Fi technology is inherently polite in the methods used by individual devices to gain access to the radio channel. Applications that do not use a similar polite protocol could be disruptive to Wi-Fi networks and therefore should be accommodated outside the Wi-Fi bands. Ofcom should oppose new radio technology standards targeting the Wi-Fi bands that do not politely share spectrum with Wi-Fi equipment.

New standards for operation of Wi-Fi technology in the TV white space spectrum (802.11af) and the 60GHz spectrum (802.11ad) are suited to particular applications. Future examples would include machine-to-machine usage in the TV white spaces (such as for smart metering) and direct device-to-device communication at 60GHz (such as ultra HD TV streaming within the home, as mentioned by Ofcom). These examples would clearly impinge on the capacity at 2.4GHz and 5GHz if they were instead to operate in the current bands used by Wi-Fi. A full technology neutral approach may therefore not be appropriate in cases where this would seriously impact spectrum efficiency and quality of services that consumers enjoy within the licence-exempt Wi-Fi bands.

*Question 4: What role do you think Wi-Fi will play in providing wireless broadband connectivity outdoors over the coming 5-10 years?*

BT provided its views on role of Wi-Fi outdoors in response to the recent Ofcom call for input on Licence Exempt spectrum use in the 2400 MHz band. BT was a pioneer of UK public wireless LAN (Wi-Fi) in this band with its BT Openzone service, and its spectrum experts were active in working with Ofcom to define the necessary Interface Requirements and ETSI standards. BT Openzone is now incorporated under the BT Wi-Fi umbrella, which has more than 5 million hotspots across the UK. Over the past year more than 20,000 new hotspots were added each week and over 400 million connections were made across the network. The latest figures show users' online Wi-Fi time is increasing, with minutes more than tripling in the same period.

As a further strand to outdoor use by BT, we also deploy blanket Wi-Fi coverage outdoors at city centre locations under the Wireless Cities initiative. There are already twelve wireless cities, and we continue to roll out such solutions.

With data-hungry consumers and businesses owning increasing numbers of smartphones and tablet computers, and with the latest Wi-Fi standards and techniques providing for easy connection, improved battery life etc, we anticipate that Wi-Fi will continue to grow in popularity. This will include when devices are used outdoors such as at hotspots and in wireless cities. As data demands on mobile broadband networks increase, operators will offload more and more data onto Wi-Fi networks where they can, including outdoor public networks. Thus use of Wi-Fi outdoors will remain important for the foreseeable future. Additionally we note that any analysis should not cover outdoor alone as outdoor connectivity goes hand in hand with indoor connectivity. Services increasingly require session and service handover between all contiguous locations as well as between technologies.

Efficient handover between licensed mobile broadband (e.g. LTE) and Wi-Fi (and vice versa) continues to be further standardised creating a true heterogeneous network approach for mobile data use. The GSMA recently provided recommendations for the minimum Wi-Fi capabilities that should be expected in future terminals[4]. So far 85 devices have already been certified[5]. As these enter the market through handset churn, authentication and handover will become seamless to the user and, together with new services, will drive the use of available capacity on the most appropriate network at that time and location. Additionally licensed mobile networks will increasingly use licence exempt Wi-Fi networks as a spectrum extension. Bearing all these factors in mind, we caution that outdoor use of Wi-Fi should not be examined in isolation but should be considered as a part of the whole mobile broadband landscape.

Wi-Fi can be used to deliver connectivity to households under community broadband schemes. These use spectrum in a small area only, and in reality there are relatively few of these schemes in the UK. We do not anticipate that there will be an explosion in popularity of such schemes, which can be accommodated in existing available spectrum.

[4] http://www.gsma.com/newsroom/wp-content/uploads/2012/06/TS.22-v2.0.pdf
[5] http://www.wi-fi.org/certified-products-results?cid=&org=0&category=38&start_date%5Bdate%5D=&end_date%5Bdate%5D=&capabilities%5B63%5D=63&op=Search&form_build_id=form-TwMqWjeEv3AuhIJN53ToHzSumj-N2mJQj6buqgMbaWE&form_id=wifi_cert_api_advanced_search_form

*Question 5: Will the increased deployment of Wi-Fi access points outdoors create a risk of reduced quality of service performance over the longer term and, if so, will approaches to co-ordinate access point performance be able to mitigate this risk?*

Deployment of access points from different operators in the same area will always cause a reduction in service to each operator, which is minimal when the number of networks is low and/or the traffic load is low. Coordination through voluntary operator cooperation over channel allocation and access point siting will help to alleviate performance issues. Increasing use of the 5GHz band (and any future extensions to the band) will also help with mitigation.

*Question 6: Will improved approaches to accessing spectrum in licence exempt bands be needed in the longer term to maintain the quality of service achievable for outdoor public mobile broadband and/or M2M services? If so, which approaches are most likely to be adopted and how likely do you think they are to be successful in improving access to spectrum?*

Controlled access to spectrum using a geolocation database system is proposed for the TV white space spectrum, and is feasible in the longer term in other bands. This will result in increased spectrum efficiency. Over time Dynamic Spectrum Access (DSA) may have a role in some bands, including spectrum sensing. Dynamic Channel Allocation (DCA) is already standardised in DECT, for sharing between DECT devices by automatically and continually detecting the best time slot/frequency combination on the fly. This is a distributed mechanism that is controlled at the handset. BT Wi-Fi hubs also have spectrum sensing capabilities for determining the 'least congested' channel for optimum operation, and 5GHz Wi-Fi access points for outdoor use already detect and avoid another technology sharing the band (radar) through the Dynamic Frequency Selection (DFS) mechanism. Such techniques could be extended to other bands and are successful because the characteristics of the technologies to be sensed and shared are known in advance. To maximise spectrum efficiency this points to future sharing scenarios using DSA in any particular band being restricted to technologies for which sharing compatibility has been established, rather than permitting a wide range of technologies in a band meeting basic requirements but not necessarily coexisting optimally (c.f. the 2.4 GHz band situation as an example).

**Increasing spectrum supply and better managing its use**

*Question 7: Which frequency bands are most likely to be best suited to providing geographical shared access, including via a geolocation database approach, for use by mobile broadband, for example small cells and M2M applications?*

Aside from the TV bands where Ofcom already has a white spaces project under way, the geographic shared access concept could be explored in bands where full release is not possible. This may include MoD bands that are to be opened for sharing.

*Question 8: Would access to these bands best be realised through licensing or licence exemption?*

The licensing regime will depend on the incumbent services, level of access envisaged and the particular type of shared access offered. For TVWS devices licence exemption is a pragmatic

approach. For other bands a concept such as Licensed Shared Access (LSA) may be appropriate as this would be a means of securing more permanent access to spectrum of guaranteed quality.

*Question 9: Do you believe that tiered shared access to a range of spectrum bands has a role in meeting demand for mobile and wireless data and, if so, which applications and devices do you think will be particularly suited to this access model?*

We agree that various forms of spectrum access are needed, and where these share the same bands in a tiered fashion a more efficient use of spectrum is possible with each application getting the particular quality of service or reliability that it may require. As an example, the tiered model could be suitable for certain M2M applications in the lowest tier that may be more tolerant to delays and temporary spectrum unavailability than real-time services. Care would need to be taken to avoid applications on the lowest tier being locked out of spectrum for long periods (or indefinitely) by the actions of users in higher tiers (c.f. current US concerns).

*Question 10: Do you believe DSA could play an important future role in the future in enabling a better quality of service and low barriers to spectrum access alongside conventional licensed and LE spectrum approaches?*

We agree with Ofcom's examination of potential enhancements to DSA in clause 4.28. In particular, the efficacy of any shared access scheme (including in the TV bands) could be increased by providing for spectrum management of the active devices within a technology, so that deployment parameters such as power and channel could be varied based on the knowledge of the devices requesting and using the spectrum at any one time. Currently Ofcom's white spaces proposals in the TV bands do not allow for databases to act on deployment knowledge, resulting in TVWS devices choosing channels offered by the database that are already in use by other TVWS devices. Following the pilot phase this year the TVWS licensing regime is due to be authorised in 2014. We suggest that spectrum management functions could be added to databases in the 2016 timeframe.

On the question of sensing, we have already noted in our response to Q6 that both DECT and Wi-Fi employ spectrum sensing techniques already (DCA and DFS). Such techniques could be extended to other bands and are successful because the characteristics of the technologies to be sensed and shared are known in advance. In DSA and the TV bands in particular, sensing could be added to the licensing regime in the medium term, as the techniques are further developed and adapted for each band in turn.

*Question 11: What barriers still remain to the realisation of cost-effective sensing appropriate for low-cost consumer devices and what activities are on-going to try to address them?*

As an operator BT offers no response to this question.

*Question 12: Over what timescales could DSA become a mass market proposition?*

Geolocation databases are the heart of any DSA system and are operational in the US, and about to begin pilot trial in the UK. The date for 'mass market' take up will depend on the usual factors such

as services offered, device availability, etc. With a very wide range of potential service offerings in the TV band spectrum it is not possible to say which of these might reach a particular level to be given this 'mass market' tag, or when this would occur.

*Question 13: What role should Ofcom play, if any, to support the development of DSA and relevant technologies?*

Ofcom currently has a project leading to licensing of TV white space devices in 2014. This will, for the first time in the UK, specify the necessary database systems and the interaction of devices with them. This capability will need to be extended to exploit the channel usage reported by white space devices to the database so that it can be used for spectrum management purposes. In parallel Ofcom should work to extend the concept of DSA to other bands.

*Question 14: Do you have any other views on any of the issues discussed in this consultation?*

No.

**Supporting innovation through short-term access to shared spectrum**

*Question 15: What are the frequency bands that would be of most value for R&D purposes?*

Short-term access for R&D could focus on bands not already assigned to operators but of greatest interest to researchers. At this current time the 2.3GHz band is an example for those interested in mobile broadband.

*Question 16: What are the potential benefits of using a geolocation database approach for short-term access to spectrum for R&D and how would you see this working from a practical perspective? Are there alternative approaches that could deliver similar benefits?*

We welcome the concept described by Ofcom. Where public sector spectrum is under-utilised or spectrum has been cleared, Ofcom should be able to grant licences in time periods and locations where it is unused. The current process to issue temporary licences for testing and development work is lengthy. The idea of an online geolocation database to control R&D access to such spectrum is worthy of exploration if this would speed up the provision of licences. Care would need to be taken to include safeguards preventing 'spectrum hoarding' by researchers in popular bands if access could be granted at a click of a button. Checks and warranties would still be required to show that a request is for genuine test and development use. Confidentiality would also need to be ensured for access requests and licences granted, in order to protect commercial interests.

*Question 17: What characteristics do you view as important to researchers in arrangements to facilitate temporary access to spectrum for research and development purposes?*

As mentioned in previous answers, low cost licences for R&D usage that could be issued rapidly would be very advantageous. An electronic online application process would be beneficial.