Dynamic Spectrum Alliance response to Ofcom's consultation on the Future Role of Spectrum Sharing

The Dynamic Spectrum Alliance ("DSA")[1] is pleased to have the opportunity to contribute to Ofcom's consultation on the role of spectrum sharing in increasing the availability of wireless services and improving spectral efficiency.

Given the rapid rise in demand for wireless connectivity, efficient and adaptive management of spectrum has become more important than ever. As a result, Ofcom should pursue policies that:

- Extend the reach of wireless network coverage, to reduce 'not-spots' and enable users of mobile devices to enjoy continuity of access to increasingly important online services;
- Add to the capacity available for wireless networking, supporting ever-higher video streaming quality and other data-intensive applications that are enjoyed via mobile devices;
- Facilitate flexibility that will enable ad-hoc networking, allowing end users to deploy infrastructure when and where they need it—thus helping to meet the needs of applications where suitable pre-planned networks may not be available (e.g., in disaster situations, where existing infrastructure may be impaired to some degree or totally absent);
- Enable emerging applications of wireless technology, such as machine-to-machine (M2M) communications;
- Promote innovation in the wireless sector; and
- Make additional spectrum available and usable as quickly as possible.

Two key strategies will allow Ofcom to make progress toward these goals: (1) increasing the spectrum available for use by licence-exempt devices and (2) enabling increased spectrum sharing.

Increasing spectrum available for licence-exempt devices

We believe that licence-exempt devices (such as Wi-Fi devices) will continue to have a critical role in helping to meet the growing demand for wireless Internet access. Industry is investing in evolving the standard to meet the requirements for greater capacity. However, regulators can also play an important role by ensuring that suitable harmonised bands are available for use.

Enabling licence-exempt use—which is likely to be used by Wi-Fi devices—will also serve as a key tool in meeting the wireless demands of the future.

[1] The Dynamic Spectrum Alliance is a global, cross-industry alliance focused on increasing dynamic access to unused radio frequencies.

- First, opening up additional spectrum for Wi-Fi and other unlicensed uses will create increased coverage for wireless devices. For example, increasing the spectrum available for metronets and other hot-spot approaches has the possibility to increase low-cost wireless Internet access, especially in outdoor areas.
- Second, enabling additional licence-exempt use will increase capacity. In many countries, more traffic travels over licence-exempt networks than licensed networks. Indeed, the rapid increase in traffic offloading from macrocell networks to Wi-Fi networks demonstrates that licence-exempt uses serve critical role in improving overall wireless capacity. This is especially true in congested areas that would benefit from increased small-cell coverage for offload.
- Third, enabling licence-exempt access can be accomplished quickly. By establishing simple interference rules, streamlining type-approvals, taking advantage of a global market, and relying on existing industry processes for standardization, licence-exempt devices are likely to come to market quickly.
- Fourth, licence-exempt access enables innovation. Because licence-exempt devices are free from the burden of normal delays associated with the licensing process, and the use of the spectrum itself is not subject to licensing fees or auction participation, manufacturers can rapidly develop equipment to fill a unique need and introduce into the marketplace quickly.[2] In fact, many of the newest wireless devices—such as the new wave of networked devices commonly referred to as the Internet-of-Things—will rely exclusively on licence-exempt spectrum[3].

Enabling increased spectrum sharing

Sharing spectrum will serve as a key tool in meeting the wireless demands of the future.

- First, sharing has the ability to increase capacity because it makes fallow spectrum available without displacing incumbent users. Ofcom will need to consider methods beyond the traditional model of dedicating spectrum to individual uses if rapidly rising demand is to be met. Spectrum sharing will be an important way to unlock maximum value from wireless applications.
- Second, because using shared spectrum need not require significant up-front investments on the part of network operators, it should serve as a flexible way to increase capacity, reducing artificial scarcity.
- Third, spectrum sharing, especially in sub-1 GHz spectrum, can create increased coverage for wireless devices. Spectrum under 1 GHz has favourable propagation characteristics, allowing signals to penetrate buildings and irregular terrain. Sharing in these bands has the potential to increase the reach of wireless broadband, especially in rural and hard-to-reach areas. It also allows trade-offs

[2] Kenneth R. Carter, Ahmed Lahjouji, & Neal McNeil, FCC, *Unlicensed and Unshackled: A Joint OSP-OET White Paper on Unlicensed Devices and Their Regulatory Issues*, OSP Working Paper Series, at 5 (May 2003).

[3] Richard Thanki, "The Economic Significance of Licence-Exempt Spectrum to the Future of the Internet", June 2012, (June 2012)

between power, range, and throughput, enabling lower energy consumption. Allowing licence-exempt access to television white spaces is an important example of this type of sharing.

- Fourth, sharing can be accomplished quickly. It offers a much faster route to increased capacity than is possible with traditional clearing or refarming approaches. And in some cases, database-based sharing technologies will be able to use newly available spectrum without requiring a change in hardware, further speeding improved spectrum utilisation.

More intensive dynamic spectrum sharing should be a key regulatory objective, enabling regulators to accommodate varying demands of different uses. Over time, sharing should become the default policy, in sharp contrast with the traditional practice of allocating particular bands to specific uses.

By establishing wide bands for sharing (Spectrum Superhighways, as the U.S. President's Council of Advisors on Science and Technology put in in their report published in 2012[4]), regulators can create the capacity needed by emerging applications and establish the flexibility to respond to changes in market needs and opportunities for international harmonisation, for example.

Q1: How is demand for indoor wireless data connection speeds and capacity likely to develop over the next 5–10 years?

Use of Wi-Fi, including indoor Wi-Fi networks, has skyrocketed in recent years. According to recent estimates, Wi-Fi today accounts for approximately 80% of all data traffic from smartphones and tablets,[5] and 73.3% of UK residents have access to Wi-Fi in their homes, one of the highest rates of penetration in the world.[6]

We expect rapid growth in wireless network traffic indoors, as networking technology evolves and consumers embrace a growing range of tetherless devices and cable-free installations. The services which consumers access will also improve in quality with attendant growth in bit rate.

Cisco projects that by 2017:

- There will be 3.6B global Internet users, up from 2.3B global Internet users in 2012;
- There will be 19B networked devices globally, up from 12B networked devices in 2012;

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[4] Executive Office of the President, President's Council of Advisors on Science and Technology, *Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth*, Report to the President, at vii (July 2012), *available at* http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_spectrum_report_final_july_20_2012.pdf.

[5] Mark Cooper, *Efficiency Gains and Consumer Benefits of Unlicensed Access to the Public Airwaves* at 13 (Jan. 2012) *available at* http://www.markcooperresearch.com/SharedSpectrumAnalysis.pdf

[6] European Commission, *Study on impact of traffic offloading and related technological trends on the demand for wireless broadband spectrum* 49 (2013), *available at* https://bookshop.europa.eu/en/home

- Average global broadband speed will be 39 Mbps, up from 11.3 Mbps (2012); and
- Global IP traffic will reach an annual total of 1.4 zettabytes (billion terrabytes), up from 523 exabytes (million terrabytes) in 2012.[7]

In line with this growth in Internet connectivity, independent studies suggest that demand for indoor Wi-Fi will continue to increase and wider channels will be required to deliver higher data-rate services such as HD video streaming.[8]

Q2: 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?

Yes, with the extension of licence-exempt use, 5 GHz offers significant capacity for Wi-Fi growth.

Wi-Fi will have a growing role in indoor wireless connectivity. According to ABI Research, Wi-Fi shipments will approach 3 billion per year in 2016, nearly doubling the 1.5 billion shipments seen in 2012.

- 42% of this growth was in the consumer electronics category, feeding demand for indoor Wi-Fi connectivity.
- Sales of Wi-Fi enabled handsets grew 32% from 2011-2012.

Granting access to contiguous spectrum and raising power levels across the band would enable a far more efficient band plan, with wider channels (up to 160 MHz), thereby facilitating provision of higher data rates to users, through the recently introduced 802.11ac technology. If additional spectrum from 5350-5470 MHz were made available for Wi-Fi use, this addition would result in a 675 MHz-wide band (from 5150 to 5825 MHz).

We conclude that additional spectrum suitable for Wi-Fi will be required and that an extension of the available capacity in 5 GHz would have a substantial role to play in meeting the anticipated demand.

Q3: Are there other types of indoor wireless applications will require access to alternative spectrum other than that provided by the licence exempt 2.4 and 5 GHz bands used by Wi-Fi?

We expect Wi-Fi to continue to be the dominant indoor wireless network technology, with an increasing array of applications using the ubiquitous and cost-effective connectivity it provides. In particular, we expect that increased demand for video streaming, especially in high definition, will drive demand for increased indoor Wi-Fi connectivity.

We expect the TV white spaces (470 to 790 MHz) to rapidly become a core Wi-Fi band, given the enhanced coverage and additional capacity that it can offer. This is a useful complement to the higher bandwidth available in higher frequency bands. In particular, Wi-Fi below 1 GHz can offer indoor coverage at lower power levels.

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[7] Note that while Ofcom's consultation focuses on the growth of Wi-Fi, there is likely to be similarly explosive growth in a variety of licence-exempt technologies, including Bluetooth, Zigbee, RFID, and other machine-to-machine ("M2M") communications. As a result, improved allocations for licence-exempt spectrum—discussed in greater detail below—will power the entire licence-exempt economy, not just Wi-Fi technologies.

[8] Increased width does not necessarily require contiguous channels, although they are preferred, because IEEE 802.11ac and af technologies support aggregation of non-contiguous channels.

Wi-Fi at 60 GHz will increasingly have a more significant part to play in distribution of content and access to high bandwidth content indoors because devices will be capable of offering more bandwidth than hardwired USB 3.0 connections. However, 60 GHz spectrum is only suitable for in-room distribution. ABI Research forecasts that annual shipments of devices supporting both Wi-Fi and Wi-Gig technologies will reach 1.8 billion by 2016.

Other bands should be assessed routinely for suitability for Wi-Fi and other licence-exempt applications on a primary or shared basis.

Q4: What role do you think Wi-Fi will play in providing wireless broadband connectivity outdoors over the coming 5-10 years?

Consumer demand for outdoor Wi-Fi hotspot access (e.g., outdoor cafes, and municipalities) is rapidly increasing as mobile smartphone use and cloud computing become more mainstream. According to a market research study by Markets and Markets, the outdoor Wi-Fi services market "is expected to grow from $15.41 billion in 2013 to $37.2 billion in 2018, at a CAGR of 15.82% during this forecast period."[9] In the United States, cable providers have already deployed more than 150,000 outdoor hotspots.

The addition of the TV white spaces band to Wi-Fi through the IEEE 802.11af standard will enable more comprehensive outdoor coverage for a given deployment density of access points.

Q5: 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?

In the future, we expect development of automatic configuration/coordination techniques (e.g., based on cognitive technologies) to reduce the costs and increase coverage efficiencies. For example, geo-location database and cognitive sensing could be used independently or in combination to enable co-existence between operators, and technologies in the same area. Moreover, making more spectrum available for Wi-Fi will likely reduce the need for highly detailed coordination.

Q6: 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?

We believe that the use of geolocation databases and other dynamic access technologies (including spectrum sensing) will allow a greater range of uses and applications than would have been possible previously with licence-exempt access.

Q7: 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?

The key bands identified for spectrum sharing to date include:

- Spectrum below 790 MHz, including the TV white spaces;

[9] Markets and Markets, Outdoor Wi-Fi Network Worth $37.2 Billion By 2018, http://www.marketsandmarkets.com/PressReleases/outdoor-wi-fi.asp (last visited Oct. 31, 2013).

- 3.55 GHz to 3.7 GHz; and
- A range of underused bands allocated to government users, including 230 MHz, 400 MHz, and portions of the 5GHz band.[10]

The TV white spaces are well suited for M2M applications as well as wireless broadband networks.

These bands are illustrative and make good targets for initial attempts at sharing. Nevertheless, a geolocation database approach is not band-specific, and Ofcom should explore sharing to maximize usage and efficiency of the spectrum wherever possible.

Q8: Would access to these bands best be realised through licensing or licence exemption?

Licence exemption, using dynamic spectrum access, enables effective sharing and lowers barriers to entry for innovations in services and technology. Regulators should aim to take full advantage of international harmonisation activities—such as in the bands listed above.

Q9: 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?

Yes, we believe that tiering can be helpful in sharing spectrum between diverse applications However, tiering should be kept as simple and transparent as possible, and policymakers should seek harmonisation opportunities as they implement any tiering frameworks. In all cases, making a healthy amount of spectrum available for licence-exempt use is critical to maintaining a healthy secondary tier of low-cost devices.

Examples of services that can take advantage of secondary access might include local networks of small cell devices and emergency services.

Q10: 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 licenced and LE spectrum approaches?

Yes, dynamic spectrum sharing can play a critical role in improving efficiency, allowing improved quality of service, and removing barriers to spectrum access.

- Dynamic spectrum sharing technologies improve spectrum utilisation by freeing up spectrum that otherwise could not be used because it is occupied by incumbents in discrete, possibly sporadic, locations or at intermittent times. In essence, dynamic spectrum sharing allows policymakers to enable use of vacant spectrum by flexible secondary users. Moreover, because dynamic sharing approaches do not require clearing incumbents or conducting complicated auctions, they can be implemented quickly.

[10] I n October 2012, Microsoft released a report on research into the assessment of spectrum suitability for dynamic spectrum access techniques. *See* Aakanksha Chowdhery, Ranveer Chandra, Paul Garnett, and Paul Mitchell, Characterizing Spectrum Goodness for Dynamic Spectrum Access (2012), *available at* http://research.microsoft.com/apps/pubs/?id=174795 (last visited Oct. 31, 2013). The intention of this work is to assist regulators in identifying bands beyond the TV white spaces that are suitable for dynamic spectrum access.

- Dynamic spectrum sharing can also improve quality of service. Using dynamic spectrum sharing techniques to increase the number of bands available for Wi-Fi use improves both the reliability and range of Wi-Fi technologies.
- By bringing previously unavailable spectrum online, dynamic spectrum sharing can reduce overall spectrum scarcity.
- Where dynamic spectrum sharing approaches are accompanied by a licence-exempt framework, spectrum can be accessed relatively quickly and at low cost, reducing barriers to market entry.
- Dynamic spectrum sharing technology provides the flexibility to adapt to rapid evolution of market demand and reconcile this with the fragmented availability of capacity arising from historical spectrum allocations and varying speed of change between countries and regions.

Q11: 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?

Cost-effective sensing technology is already available to support consumer devices in some cases. For example, dynamic frequency selection is widely used in the 5 GHz band. Regulatory support for database or sensing solutions, whether used separately or in combination, could free up additional spectrum for sharing. Sensing has a dual use in helping to detect incumbents as well as helping with interference management.

Q12: Over what timescales could DSA become a mass market proposition?

With regulation established to enable access to the TV white spaces, we expect penetration of these sharing technologies to accelerate to the point where there are substantial deployments within 3 years. The primary impediment to significant investment and large-scale deployment is regulatory certainty regarding the availability of spectrum for sharing. For example, there are proposals in some markets to roll back broadcast spectrum further and repack the TV transmissions, reducing white space availability.

Q13: What role should Ofcom play, if any, to support the development of DSA and relevant technologies?

Overall, Ofcom can support sharing by (1) making enough spectrum available for sharing to support industry investment and (2) developing flexible, straight-forward rules for secondary users that encourage investment, innovation and use. Ofcom should work to remove uncertainty regarding the use of shared bands, as this uncertainty makes new manufacturers hesitant to invest in new devices and operators hesitant to build networks.

Ofcom can take several specific actions to support spectrum sharing. First, Ofcom should finalise its work on enabling licence-exempt access to the TV white spaces. Second, it should make spectrum usage data as fully available as possible (especially in bands where planning is the responsibility of the regulator—e.g., the broadcast bands). Third, Ofcom should add any unused spectrum to the geolocation database as quickly as possible as soon as the capacity is available. Fourth, it should work with the industry to clear the way for dynamic sharing to be applied more generally across all bands, with priority being given to those bands where there is a prospect of international harmonisation in the near future.

Q14: Do you have any other views on any of the issues discussed in this consultation?

[DSA has no comment on this question.]

Q15: What are the frequency bands that would be of most value for R&D purposes?

Making additional spectrum below 1 GHz available for research and development will encourage innovation, given the coverage benefits afforded by lower frequency spectrum. Wideband opportunities between 1 GHz and 10 GHz are also of interest. Experimental devices should be able to use new license-exempt bands so long as they adhere to the no-interference/no-protection standard.

Q16: 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 believe that using a geolocation database for short-term access to spectrum could boost research and development by encouraging investment in the design of flexible hardware that could opportunistically exploit such fragments.

Q17: What characteristics do you view as important to researchers in arrangements to facilitate temporary access to spectrum for research and development purposes?

Ofcom can facilitate research and development by providing clarity regarding both current uses of spectrum and which spectrum may be available for research purposes. It can also streamline the process of obtaining authorizations for conducting research. Databases can enable effective sharing of spectrum usage information and may be able to assist in streamlining the process of obtaining authorizations.