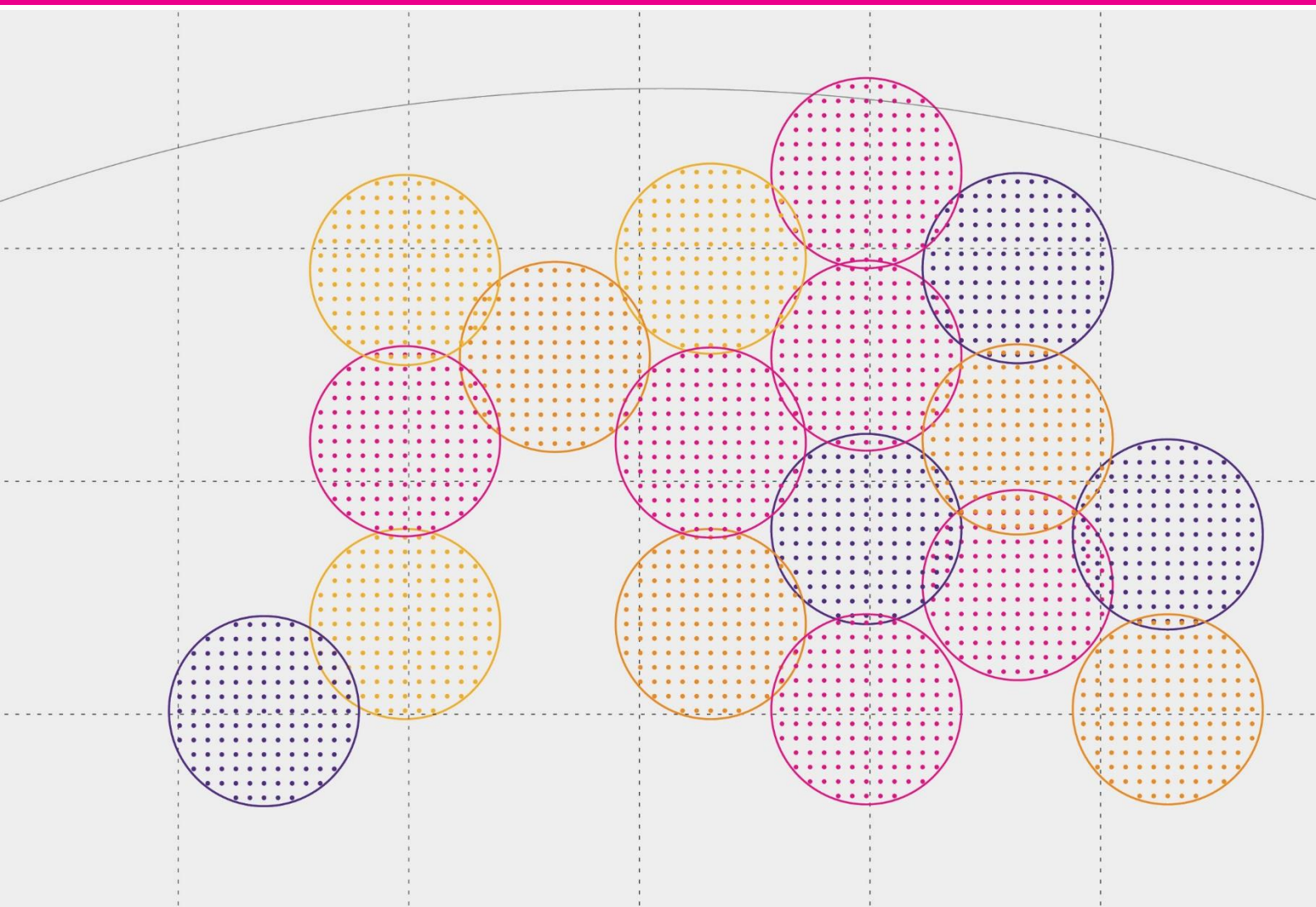


# SPF Cluster 3: The future of spectrum sharing in the UK

27 January 2022

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## About Plum

Plum offers strategy, policy and regulatory advice on telecoms, spectrum, online and audio-visual media issues. We draw on economics and engineering, our knowledge of the sector and our clients' understanding and perspective to shape and respond to convergence.

## About this study

This report for UK SPF provides a summary of the Cluster 3 workshops on spectrum sharing held in 2021. It also provides feedback obtained from a short research programme with key stakeholders. The report provides recommendations for DCMS and Ofcom.

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## About the UK Spectrum Policy Forum

Set up at the request of Government the purpose of the Spectrum Policy Forum is to be a pro-active industry-led 'sounding board' to UK Government and Ofcom on future policy and approaches on spectrum and a cross-industry 'agent' for promoting the role of spectrum in society and the maximisation of its economic and social value to the UK. The Forum delivers its mission by exchanging news and views on developments in using spectrum, drawing on our industry expertise from around the world.

The Forum is open to the full range of UK spectrum users. Members currently include over 240 companies and organisations with an interest in using spectrum for a diverse range of applications. In this context the term 'spectrum users' is to be interpreted in the widest sense -including all industry sectors which use (or will use) wireless techniques and organisations involved in the entire value chain in these activities.

The Steering Board ensure that the work of the Forum is properly framed, work items expedited in the correct manner and suitably resourced, and monitor progress on the delivery of the agreed work packages.

### **The current members of the Steering Board are:**

Department for Digital, Culture, Media & Sport (DCMS)

Ofcom

Ministry of Defence (MOD)

Digital TV Group (DTG)

BT

Huawei

OneWeb

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# 1 Introduction

This report provides a summary of the Cluster 3 workshops on spectrum sharing held between 18<sup>th</sup> June 2021 and 30<sup>th</sup> September 2021. It also provides feedback obtained from a short research programme carried out among several parties with an interest in spectrum sharing (including some SPF Steering Board members).

DCMS set the terms of reference for Cluster 3 to undertake a review of spectrum sharing in the UK and the extent to which current shared spectrum access is creating the conditions for new players to provide innovative 5G services.

Key background points on spectrum sharing are:

- Spectrum sharing was identified in both the 2018 Future Telecoms Infrastructure Review (FTIR)<sup>1</sup> and the 2019 Statement of Strategic Priorities (SSP)<sup>2</sup> as a key issue. The FTIR saw spectrum sharing playing an important role in the market expansion model for mobile.
- Ofcom has enabled spectrum sharing options through new shared access licences (Local Access Licence – LAL and Shared Access Licence – SAL). These licences were set out in Ofcom’s Statement on “Enabling wireless innovation through local licensing” published in July 2019.<sup>3</sup> Ofcom has published guidance on LAL and SAL.<sup>4</sup>

The LAL enables the shared use of spectrum which is already licensed on a national basis to mobile network operators (MNOs) in locations where a particular frequency is not being used. The default licence period for a LAL is three years. However, it may be possible to negotiate a longer licence term with the existing licensee, in which case Ofcom would issue a licence for a longer period. For successful applications Ofcom charges a licence fee of £950. Frequencies in scope for LAL are:

- 791-821 MHz paired with 832-862 MHz
- 880-915 MHz and 925-960 MHz
- 1452-1492 MHz
- 1710-1781.7 MHz and 1805-1876.7 MHz
- 1900-1920 MHz
- 1920-1980 MHz and 2110-2170 MHz
- 2350-2390 MHz
- 2500-2690 MHz
- 3410-3600 MHz

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<sup>1</sup> Future Telecoms Infrastructure Review (FTIR) available at <https://www.gov.uk/government/publications/future-telecoms-infrastructure-review>

<sup>2</sup> DCMS Statement of Strategic Priorities designated on 29<sup>th</sup> October 2019 available at <https://www.gov.uk/government/publications/statement-of-strategic-priorities>

<sup>3</sup> Ofcom Statement: Enabling wireless innovation through local licensing available at <https://www.ofcom.org.uk/consultations-and-statements/category-1/enabling-opportunities-for-innovation>

<sup>4</sup> Ofcom Local Access Licence guidance document available at [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0037/157888/local-access-licence-guidance.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0037/157888/local-access-licence-guidance.pdf) and Shared Access Licence document available at [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0035/157886/shared-access-licence-guidance.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0035/157886/shared-access-licence-guidance.pdf)

- Spectrum recently auctioned in the 700 MHz band and 3.6-3.8 GHz will also fall within scope of LAL.

The SAL is aimed at providing access to spectrum for users such as small businesses, industry verticals and others to support innovation and new use cases. Ofcom grants individual shared access licences. There are two types (note that neither authorises airborne use): Low power, which authorises users to deploy as many base stations as they require within a circular area with a radius of 50 metres; and medium power for users who need a longer transmission range from their base station, but don't expect to need to change the locations of base stations once they're deployed. The medium power licence authorises a single base station. Approved SAL applications provide licenses granted on an indefinite basis (unless revoked by Ofcom). Fees depend on the channel bandwidth required except for the 26 GHz band for which there is a flat rate fee. SAL also contains a "use it or lose it" provision. Frequency bands for SAL are:

- 1781.7-1785 MHz paired with 1876.7-1880 MHz
- 2390-2400 MHz
- 3.8-4.2 GHz – 390 MHz of spectrum available (note that this spectrum cannot be used for the provision of national mobile broadband services)
- 24.25-26.5 GHz for indoor low power licences only.

Against this background Cluster 3 was asked to consider:

- The spectrum needs for different business models and 5G services (this was the topic for the first workshop).
- A review of the Local Access Licence and Shared Access Licence regimes (this was the topic of the second workshop).
- Recommendations on the potential for Dynamic Spectrum Access (DSA) to be introduced in the UK in either the current shared access bands or in other bands (this was the topic of the third workshop).

More generally the workshops considered barriers to sharing and policy of other administrations on sharing in as far as it was possible to do so. Examples of the barriers identified include inability to gain access to spectrum, the lack of a viable ecosystem and development of viable business cases.

The research programme covered similar ground to that set out above, aimed to provide more detail and offered a means for comments to be made that might not be possible in the workshops. All information is presented on an anonymous basis except where the origin is clear (e.g. slides presented at the workshops).

We would like to thank everyone at the workshops and in the interviews for their contribution to this study.

The remainder of this report is structured as follows:

- Section 2 sets out key inputs from the workshops and research.
- Section 3 provides conclusions and recommendations.

## 2 Key inputs from workshops and research

The concept of spectrum sharing has been accepted in the UK for many years (e.g. between fixed link and satellite services and more recently mobile and satellite services at 26 GHz) and, as development of white spaces and the recent introduction of LAL and SAL by Ofcom has shown, there are no legislative or regulatory impediments to the principle of further extension of spectrum sharing.<sup>5</sup> The Spectrum Strategy published in 2014 foresaw that there is considerable potential for generating more value from spectrum by increasing the amount of sharing that takes place.<sup>6</sup>

Below are key points from the workshops and stakeholder interviews.

### 2.1 Demand for shared spectrum

The primary focus for this report was 5G but other technologies were considered where relevant – one plea from some users was not to forget the needs of non-Electronic Communications Services (ECS) operators (e.g. provision of mission critical capability for utilities and others).

Given the early phase of development for 5G shared spectrum solutions, there was little information presented on what the dimensions of shared spectrum demand might be in the near to medium term. A similar position emerged on the level of flexibility that might be possible with spectrum sharing in longer term. Hence, it has not been possible from this work to determine a clear view of the demand profile for access to shared spectrum. However, there is a general expectation that demand will increase and there is evidence of demand from the applications made to Ofcom for shared spectrum access. Some concerns were raised about the difficulty of accurately identifying latent demand (the inability to satisfy demand through lack of awareness of suitable products or information). It was also unclear how much demand will be served by MNOs vs other providers (e.g. how Mobile Private Networks (MPNs) will develop and who will provide them?).

A key driver for spectrum demand is current and emerging communications use cases:

- There is a body of learning around use cases (and spectrum sharing) that can be reviewed and potentially leveraged from the 5G Testbeds and Trials (5GT&T) activity – 5GT&T has utilised both the shared licences put in place by Ofcom in addition to use of test and development and other spectrum licence products. 5GT&T has covered multiple scenarios including urban, rural, industrial manufacturing and construction, health and social care, and others. An objective of the 5GT&T programme was to assist with driving adoption of 5G.<sup>7</sup> However, the need to develop a more thorough understanding of end users and use cases that might need access to shared spectrum was raised as an issue. This is starting to happen but is inevitably a work in progress across the mobile and other industries who are learning to handle new wireless communications solutions.
- Key issues raised by existing / potential users of spectrum are demonstration of a viable business case for investment and having access to readily available inputs to develop options for solutions. Two key inputs are understanding what spectrum could be available (including the two schemes put in place by Ofcom), and ecosystem availability – RAN (3GPP bands n77 and n258) and 5G core including 5G standalone core. Open RAN and open 5G core were seen by some stakeholders as important building blocks that need to be available to stimulate demand.

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<sup>5</sup> The Digital Economy Act 2017 contained provisions relating to databases- see Part 2A – Regulation of Dynamic Spectrum Access Services.

<sup>6</sup> See paragraphs 3.39 to 3.43. Available at [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/287994/UK\\_Spectrum\\_Strategy\\_FINAL.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/287994/UK_Spectrum_Strategy_FINAL.pdf)

<sup>7</sup> Details of activity and outputs available at <https://www.gov.uk/guidance/5g-testbeds-and-trials-programme>

Other points on demand included:

- The need for specific consideration of indoor / in building networks, noting the possibility that a very light or general authorisation scheme could be considered with use of 26 GHz spectrum indoors (i.e. less stringent than the current SAL arrangements due to the very low probability of interference when this spectrum is used in buildings). Alternatively, faster processing of licences may address the concern.
- Neutral host solutions, where they might be used and how they could be provided? The need for a better understanding of the policy and regulatory options for neutral host solutions was highlighted by several contributors. This point was also referred to in Ofcom's Statement on enabling wireless innovation through local licensing where it was noted that several stakeholders indicated that more work was needed from a regulatory perspective.<sup>8</sup> Ofcom notes in the guidance on SAL that a low power licence could be used for indoor mobile coverage extension schemes, for example through a neutral host model.<sup>9</sup>

## 2.2 Supply of shared spectrum

From the workshops and interviews there appeared to be a good understanding of the shared spectrum supply options available in the UK, including for LAL and SAL. Also that the UK is an early mover in this field. While there are inevitable frustrations with these schemes there was also recognition that they are a step in the right direction to expand spectrum supply for private networks and for innovation. The availability of spectrum through the recent Ofcom initiatives is steering towards the 3.8-4.2 GHz frequency band for 5G applications. The spectrum available for sharing under Ofcom's current schemes is summarised in Section 1.<sup>10</sup>

Automation of Ofcom's processes for applications for SAL was highlighted by stakeholders as a key area for improvement.<sup>11</sup> A good first step would be to automate the process to provide applicants with a better and more timely view of usage of spectrum in locations being considered and streamlining the application process to allow faster access to spectrum. The need for automation was acknowledged by Ofcom but it was not clear what the timeframe will be to address this, and other points raised below. The development of a more public plan by Ofcom for the next steps with SAL and LAL was viewed as a potentially helpful step.

Other points raised in our work were:

- The need for administrative improvements to application procedures (e.g. the ability to alter an application once filed, time taken to respond, the need to link multiple applications in one area together). This would lead to a more efficient application process and potentially lower barriers to applying.
- The licensing process often takes too long and can hinder commercial discussions between suppliers and customers (for example, tenders may specify response timescales that are shorter than the period required to obtain reliable information on available spectrum). This suggests the need for time based KPIs to be applied to the application process. This would provide greater certainty to applicants and network builders.

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<sup>8</sup> See Para 3.12 of Ofcom's Statement on enabling wireless innovation through local licensing available at <https://www.ofcom.org.uk/consultations-and-statements/category-1/enabling-opportunities-for-innovation>

<sup>9</sup> See Para 2.10 of Ofcom's Shared Access Licence guidance document available at [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0035/157886/shared-access-licence-guidance.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0035/157886/shared-access-licence-guidance.pdf)

<sup>10</sup> A further point raised by stakeholders was that sharing schemes should not just focus on granting non-mobile users access to mobile spectrum bands but equally apply to other spectrum use (e.g. public sector use).

<sup>11</sup> Note that automation of LAL would be much more complex as it would require interfaces to MNO spectrum processes to determine existing deployments and plans for use.



- Technical points and restrictions currently applied to licences including:
  - Whether coexistence and protection criteria are too restrictive?
  - Determination of options to site masts in relation to existing sites (some stakeholders felt the process could be imprecise and subject to multiple alterations before granting a licence).
  - Maximum permissible height of antennas at a specific location.
  - Calculation of maximum permissible power levels at a specific location.
  - The use of omni-directional antennas and the inability to handle multi-sector cells, directional antennas and MIMO/beam forming.
  - Potentially including the option to use leaky feeder systems in some locations.
  - The need for more thought on handling indoor use cases and whether Low Power Indoor (LPI) and/or Very Low Power (VLP) regimes could be considered.

Addressing technical points potentially enables further innovation and more flexible network design / implementation.

Few concerns were raised about the pricing applied to SAL and LAL. However, some suggested that Ofcom's invoicing processes could be improved to allow quicker issue of licences.

The key comment on available spectrum bands was the potential to use 26 GHz spectrum outdoors on a shared basis. This was seen as a valuable enhancement to shared spectrum supply (especially for high uplink bandwidth use cases). Access to lower frequencies was also raised for wider area coverage but the issues that come with sharing lower frequency bands, given their propagation characteristics, were acknowledged as a potential barrier. 6 GHz was also mentioned as a band where sharing could be considered. The 6 GHz band is currently the subject of studies at CEPT and ITU and is one of the bands being considered at WRC23 for IMT identification.<sup>12</sup>

## Spectrum trading / leasing

Spectrum trading / leasing were viewed as a possible mechanism for sharing of spectrum for other players to provide local access or mobile private networks (note that leasing of spectrum rights in mobile bands is not currently permitted). However, in practice, this option was not widely used for these purposes. Local Access Licences sit alongside the existing mobile spectrum trading framework as a less burdensome and more proportionate approach to provide access.<sup>13</sup>

## 2.3 Future for access to shared spectrum

There was some divergence of opinion on the future path for access to shared spectrum, beyond the need identified in Section 2.2 for automating processes for LAL and SAL. Key points raised on the path for introduction of DSA in the UK were:

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<sup>12</sup> Agenda Item 1.2 - Consider the identification for IMT of the following frequency bands: 3300-3400 MHz, 3600-3800 MHz, 6425-7025 MHz, 7025-7125 MHz

<sup>13</sup> See Paras 1.6 and 1.7 of Ofcom's Local Access Licence guidance document available at [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0037/157888/local-access-licence-guidance.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0037/157888/local-access-licence-guidance.pdf)

- One speaker proposed that “broadly speaking, spectrum sharing should only be considered where there is a clear demand for additional spectrum which otherwise cannot be made available, and where the benefits outweigh the costs.” “In other words, spectrum sharing and complex proposals for intra-service spectrum sharing in particular should not be considered as goals in themselves but must bring tangible net benefits to users of spectrum.” They did not see the need for additional spectrum sharing frameworks to cater for dynamic / opportunistic use, which could be handled by licence exempt spectrum.
- An equipment vendor saw the SAL framework as helpful and did not currently see the need for changes to this. Also that Ofcom should continue to increase the awareness of SAL and regularly update industry on the number and nature of issued licences. Other points raised were:
  - Mid-band spectrum is essential for economically viable high-capacity wider area mobile/coverage across cities for eMBB and vertical use cases. Also the need to ensure an effective balance between the desire to locally licence low power equipment vs assign new bands for use by high-power macro-cellular networks for the growth of 5G.
  - Reserving large amounts of mid-band spectrum for local use could have a high opportunity cost, and that there is a need for a cost benefit analysis of such measures.
  - The need for improving the quality of radio propagation models to ensure effective interference management. Also the importance of harmonised technical conditions and their role in the encouragement of economies of scale.
- Another speaker set out the need for handling increasing demand for wireless connectivity and for “wireless everywhere”. Key points were:
  - Wireless in buildings is much better provided from within, it delivers a better signal level, the building fabric acts to reduce interference between cells, Wi-Fi must be provided for devices for which it is the only means of connectivity and that indoor 5G is important where URLLC or similar capability is needed.
  - Wireless outdoors is cellular – but if indoor traffic moves to in-building networks then coverage is simplified, and data demands mostly off-loaded.
  - A highly automated and flexible (instant and permissive) sharing solution is needed to allow for millions of requests. It must be based on realistic protection criteria that consider building penetration and ideally feedback from license holders and others. It must provide a level of certainty for those deploying systems while allowing licence holders the full ability to use their spectrum. To do this Ofcom needs to move from a “beta trial” (i.e. the current SAL framework) to a full commercial sharing solution.

## DSA

Positions on DSA to some extent reflect the nature of specific stakeholders but they also highlight that in addition to the need to automate existing mechanisms, where there appears to be agreement, that there is not a clear objective or direction of travel around which stakeholders are grouping on DSA. Hence, no concrete position emerged for the introduction of DSA in the UK. The three viewpoints expressed in our work can be summarised as follows:

- **Just move to DSA:** The systems already exist to implement DSA solutions and there is no point waiting until unmet spectrum demand suggests that DSA is required – innovation opportunities will be missed, and it will be too late then to ensure that spectrum is used efficiently.
- **Develop a pragmatic roadmap:** The idea that the transition to DSA will be a multi-step process and that it will require more active discussion to ensure that the solution arrived at will be effective and enable access to a widely standardised ecosystem.
- **No need for DSA:** Some stakeholders were of the view that a properly automated First Come First Served (FCFS) system would be sufficient for the UK's needs for some time to come (SAL in the UK operates on an FCFS basis). Concerns were also raised that there is a need to protect investments made by incumbents given that their expectations might not have included sharing at the time they were assigned spectrum.

In all cases though there is a requirement for the application of a database approach, accurate spectrum usage information and transparency about the way in which this information is sourced. Another further point raised was the need to take account of developments outside as well as in the UK to ensure that benefits of harmonisation are not reduced. A key question to address is how authorisation of spectrum will operate in an automated sharing environment?

- Would automation still result in the issue of individual licences as in the current shared access scheme?
- Would a light licensing approach be employed or a general authorisation approach?
- Would a multi-tier (individual and general) authorisation approach be considered?

At a previous SPF workshop held in November 2020, a possible method for how public sector and in particular MOD spectrum could be accessed by users on a shared basis and the mechanisms required to enable this (based on DSA) was explored.<sup>14</sup>

## 2.4 DSA functional specification

The UK SPF Cluster 2 work on the DSA functional specification was raised in our work. This was seen as a step in the right direction with more work required to establish a clear policy within which the functional specification could be implemented. In summary:

- The design aims in the Functional Specification were:
  - Support enhanced spectrum efficiency by granting access to spectrum where and when it is available based on actual usage, whilst respecting the rights of priority assignments, and reusing spectrum in local areas small enough for it to be efficient.
  - Support for a wide range of existing and new use cases and business models.
  - Promote innovation to the benefit of UK citizen-consumers and industry.
  - Reduced overheads from the spectrum assignment process compared with manual assignment, minimising burdens and maximising scalability.

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<sup>14</sup> A summary of the event is available at <https://www.techuk.org/resource/summary-uk-spf-session-on-pssr-sharing-defence-spectrum.html>

- Greater visibility of spectrum availability and rapid access to spectrum.
- Key principles proposed in one version of the specification were:
  - Rapid introduction - not predicated on demand for administrative licences.
  - Common approach to all shared mobile spectrum bands, but with parameters and rules adapted per band (and compatible with SPF 26 GHz recommendations<sup>15</sup>).
  - Fully automated, capable of providing spectrum access grants (i.e. automatically issued licences) to equipment on request without human intervention.
  - Multiple, commercially operated Spectrum Sharing Systems, complying with Ofcom rules.
  - Ofcom retains full policy, monitoring and enforcement powers.
  - Standardised protocols, using (simplified) international standards to promote a wide ecosystem.
  - Two grant types (plus existing licences) - both are automated licences:
    - Priority grants - with sufficient duration to promote investment certainty.
    - Opportunistic - promoting spectrum efficiency and innovation.

Key principles proposed in another version of the specifications were:

- Introduction in bands nominated by Ofcom for shared access and which would otherwise not benefit from individual licensing for the deployment of wide-area public networks.
- Fully automated, capable of automatically issuing licences to users on request and without further human intervention.
- A single Spectrum Sharing System operated by Ofcom (or on Ofcom's behalf) in fulfilment of Ofcom's unique statutory duty to grant Wireless Telegraphy authorisations.
- Standardised protocols, using (simplified) international standards to promote a wide ecosystem.
- A single grant type based on local shared access licences granted on a First Come First Served (non-opportunistic) basis, promoting certainty for investment, spectrum efficiency and innovation.

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<sup>15</sup> 26 GHz – the opportunity for a fresh approach to licensing in higher frequencies. Report for the SPF. Real Wireless and Tutela. January 2021. Available at <https://www.techuk.org/resource/a-new-approach-to-spectrum-licensing-the-26-ghz-band.html>

## 3 Conclusions

### 3.1 Research questions

Cluster 3 was tasked by the DCMS to undertake a review of spectrum sharing in the UK and the extent to which current shared spectrum access is creating the conditions for new players to provide innovative 5G services. Below the specific questions raised by DCMS are addressed in the light of the workshops and research.

Research question	Outcome
The spectrum needs for different business models and 5G services	<ul style="list-style-type: none"> <li>• There is evidence through 5GT&amp;T and early 5G MPN activity that 5G shared spectrum use cases are being developed. Demand for shared spectrum is evident with applications to Ofcom for shared licences. However, demand is still at relatively low levels, there is the expectation that demand will grow but differing views on how quickly this will happen and to what extent. The workshops and stakeholder interviews did not provide hard numbers other than on current demand for Ofcom Shared and Local Access Licences.</li> <li>• 5G was highlighted as a driver for shared spectrum for MPNs as it potentially offers more deployment options and a wider range of capability but there is also demand for 4G and for other technologies (e.g. for IoT). While much of the focus for shared spectrum was for MPN to operate in spectrum identified for Electronic Communications Services (ECS), there was also interest in sharing of non-ECS spectrum (e.g. by the utility industry).</li> <li>• A key issue for those investing in / building new networks is the need for investment certainty. While no clear picture emerged on what certainty comprises, two common themes were reasonable certainty of access to spectrum at a viable cost for the duration for the investment (this could include a presumption that licences would be renewed on a rolling basis), and availability of the relevant ecosystem (e.g. 3.8-4.2 GHz, 26 GHz).</li> </ul>
A review of the Local Access Licence and Shared Access Licence regimes against the above requirements	<ul style="list-style-type: none"> <li>• There was general agreement that the licensing schemes put in place by Ofcom (LAL and SAL) are a welcome step. Concerns were raised on access to information, restrictions that need to be addressed and the process to obtain licences. The need to progress automation of the process for SAL was highlighted (why was this not done from the start?). There were also concerns about the speed of response to requests from network operators.</li> <li>• There was a clear view that Ofcom's interfaces and functionality on existing spectrum use require improvement. This needs to go hand in hand with definition of a clear workflow for handling sharing requests, provision of improved feedback to applicants and recognition that commercial requests cannot wait weeks for responses. Handling of change requests was also raised as an issue of concern.</li> <li>• Restrictions imposed on Shared Access Licences are clearly a concern for potential users (e.g. power limits, use of directional/sectorised antennas), which need to be addressed.</li> </ul>

Research question	Outcome
Recommendations on the potential for Dynamic Spectrum Access (DSA) to be introduced in the UK in either the current shared access bands or in other bands	<ul style="list-style-type: none"> <li>• A key question for Ofcom is the roadmap for automation of LAL and SAL and how far it goes? While no one argued against automation there were differing views on how far automation should go and how to progress it (e.g. automate SAL based on existing authorisation framework (no need for DSA), or move in small steps through to DSA, or make the move now to an advanced database system for nominated frequency bands).</li> <li>• On DSA specifically, a key issue is its definition. There are multiple options in terms of database mechanisms, use of sensing, access mechanisms, level of competition for provision of sharing, use of a multi-tier spectrum access framework and others. CBRS and White Space initiatives were raised in the workshops and research but also a view that the UK requires a relatively simple approach.</li> <li>• It was noted that there are already solutions available that could be considered by government/Ofcom. The work on the DSA Functional Specification undertaken by SPF Cluster 2 was highlighted as a potentially useful basis for taking work on spectrum sharing in the UK to the next step. However, the requirement for a policy framework to go around any evolution of the Functional Specification was noted.</li> <li>• The only frequency bands raised as potential candidates for sharing in addition to those already covered in the Ofcom sharing schemes were 26 GHz outdoors and 6 GHz (noting that the band is currently the subject of study within CEPT and ITU and is an agenda item at WRC23).</li> </ul>

### 3.2 International developments

We were also asked to look at examples of developments on sharing outside of the UK.

- The most visible implemented system is CBRS. It is a three-tier sharing scheme based on database and sensing technologies designed specifically for the protection of existing use of spectrum by the US Navy. The Spectrum Access System (SAS) that manages spectrum sharing on a dynamic basis across the three tiers is available as is the end user ecosystem. CBRS is in commercial use.
- In Europe Licensed Shared Access (LSA), which was originally developed for sharing in the 2.3 GHz band, is evolving. ETSI developed standards for LSA and has subsequently worked on evolved-LSA (eLSA), which will provide means to share spectrum, including automatic local area licensing and leasing agreements, and management of conditions of spectrum use.
- Policy work on sharing continues in the European Union including the recent RSPG Opinion on spectrum sharing. RSPG proposed a roadmap to achieve the objective of increased spectrum sharing. This included investigation of more dynamic spectrum sharing options and sharing of experience both in and outside of the European Union.
- For 5G, spectrum sharing has been introduced in spectrum allocation decisions, for example, in Finland (850 MHz available for localised use at 26 GHz)<sup>16</sup> and Germany (100 MHz available for localised use at 3.7-3.8 GHz and for 26 GHz).<sup>17</sup> In Hong Kong, 400 MHz at 28 GHz was made available on a shared basis.<sup>18</sup> Other administrations are considering their approach to making shared spectrum available, especially in mid-band and 26/28 GHz spectrum.

<sup>16</sup> See slide 4 of [https://www.traficom.fi/sites/default/files/media/file/02\\_Heidi%20Himmanen\\_Traficom\\_in\\_toimenpiteet\\_kohti\\_6Gt%C3%A4.pdf](https://www.traficom.fi/sites/default/files/media/file/02_Heidi%20Himmanen_Traficom_in_toimenpiteet_kohti_6Gt%C3%A4.pdf)

<sup>17</sup> For applications in spectrum for local networks in Germany in 3.7-3.8 GHz and 26 GHz see

[https://www.bundesnetzagentur.de/DE/Sachgebiete/Telekommunikation/Unternehmen\\_Institutionen/Frequenzen/OeffentlicheNetze/LokaleNetze/lokalenetze-node.html](https://www.bundesnetzagentur.de/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Frequenzen/OeffentlicheNetze/LokaleNetze/lokalenetze-node.html)

<sup>18</sup> For applications for shared 26/28 GHz spectrum in Hong Kong see <https://www.coms-auth.hk/filemanager/statement/en/upload/575/gn172021.pdf>

In general, there is still minimal information available on demand for licences available under spectrum sharing schemes except for CBRS. FCC Auction 105 made available Priority Access Licences (PALs).<sup>19</sup> PALs are tier 2 of the CBRS stack and are essentially individual authorisations.<sup>20</sup> The outcome of FCC Auction 105 was as follows:

- 228 bidders secured access to 20,625 licences.
- 2,006 licences are held by the FCC making a total of 22,631 licences.
- Up to 7 PALs available in each of 3,233 county-based licence areas.

### 3.3 Going forward

The three workshops and associated research have provided a good snapshot of the current state of play on spectrum sharing in the UK. While the focus was primarily on 5G, there was input not to forget non-ECS use cases (e.g. utilities) and other technologies (e.g. private LTE).

The concept of spectrum sharing has been present in the UK for many years (e.g. between fixed link and satellite services and more recently between mobile and satellite services at 26 GHz) and, as development of white spaces and the recent introduction of LAL and SAL have shown, there are no legislative or regulatory impediments to the principle of further extensions of spectrum sharing. The Spectrum Strategy published in 2014 foresaw that there is considerable potential for generating more value from spectrum by increasing the amount of sharing that takes place.

Demand for increased spectrum sharing is likely to be driven by MPNs and other localised applications. While it is not possible based on the input obtained for this report to estimate that demand, it is highly likely that demand will grow and increase the requirement for use of shared spectrum, which in turn will facilitate innovation in wireless use. A key question to answer is whether the existing bands subject to spectrum sharing (e.g., SAL) in the UK are sufficient for this purpose.

The introduction of DSA in the UK is a matter for further policy and regulatory consideration. A key question to address is whether waiting for evidence of demand before deciding on the introduction of DSA puts the UK at a disadvantage compared to other administrations? Alternatively, the counterfactual of persisting with the existing SAL approach and no DSA also needs to be considered. There is active development and deployment of the technology required for automated sharing and DSA, and other jurisdictions are discussing the roadmap for more dynamic spectrum sharing options. Valuable work has been done on the Functional Specification for DSA developed in Cluster 2, but this requires a policy framework to sit within to be considered further.

While the UK has made good progress with the introduction of the Ofcom spectrum sharing schemes, there is a risk that if a future spectrum sharing roadmap is not actively worked on by DCMS/Ofcom that the UK could lag other countries prepared to move faster on the introduction of automated sharing and DSA. Development of such a roadmap to maintain the momentum so far achieved in the UK should be a spectrum policy objective.

A key theme to emerge was the opportunity cost and the need for cost benefit analysis of reserving large amounts of mid-band spectrum for local use. In connection with this is the need for Ofcom to review the effectiveness of existing SAL and LAL measures at a suitable point in time.

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<sup>19</sup> Each PAL is an unpaired 10 MHz block within the frequency range 3550-3650 MHz.

<sup>20</sup> Incumbent users are Tier 1 in CBRS (highest priority and greatest interference protection and Tier 3 is for General Authorised Access – GAA (lowest priority and least interference protection). PAL users are protected from interference by GAA. Spectrum access in CBRS is facilitated via a Spectrum Access System (SAS) an automated frequency coordinator that manages spectrum sharing on a dynamic, as-needed basis across three tiers of access.

### 3.4 Recommendations

1. DCMS / Ofcom should continue to develop understanding of communications use cases that might require shared spectrum (especially but not exclusively based on 5G) through feedback on Testbeds and Trials and ongoing dialogue with industry and others.
2. There should be an increased focus on facilitating solutions for provision of indoor network capability and the authorisation regimes required to support these. (e.g. streamlining the Shared Access Licence application process, possible light licensing or general authorisation of low power 26 GHz indoors if that would be compatible with higher power licensed 26 GHz systems).
3. Concerns about neutral host solutions suggest that Ofcom should study industry concerns and provide greater clarity on regulatory and licensing issues.
4. Ofcom should publish a scope and implementation timetable for automation of shared licence applications. Also KPIs should be developed for the application process to provide greater commercial certainty to licence applicants.
5. Ofcom should address and provide solutions to the issues raised in Section 2.2 on technical matters and restrictions applied to licences.
6. DCMS should evaluate the merits of the three approaches emerging from the workshops, the counterfactual of the existing Ofcom's SAL approach and research on the introduction of DSA to determine the best approach (i.e. just move to DSA, follow a pragmatic roadmap, no need for DSA).

Cluster 3 has welcomed the opportunity to contribute to spectrum strategy / policy on this important topic.

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