QMUL Spectrum Sandbox - WP3: Economic assessment and regulatory implementation

Final report for DSIT

21 March 2025

Contents

1. Executive summary

This report has been prepared by Aetha Consulting Limited (Aetha) as a summary of an assessment of the economic benefits and approach required for regulatory implementation of dynamic access to spectrum in the Local Access Licence (LAL) and Shared Access Licence (SAL) frequency bands in the United Kingdom.

This work has been undertaken as part of a wider ‘spectrum sandbox’ undertaken for the Department of Science, Innovation and Technology (DSIT) by a consortium comprising Queen Mary University of London (QMUL), the lead partner, and Telet Research Limited (Telet), Federated Wireless and Aetha.

1.1 Introduction

Our spectrum sandbox explores the introduction of Dynamic Spectrum Access (DSA) to Local Access Licence (LAL) and Shared Access Licence (SAL) bands:

- Local Access Licence bands are frequency bands which have been assigned to the national mobile operators but there is potential for other organisations to make use of individual frequencies where they are not being used by the mobile operator to whom they are licensed.
- Shared Access Licence bands are intended for shared use by medium and lower-power users (for example local private 4G/5G networks) and the spectrum is also shared with existing users in each band (e.g. satellite, defence).

Getting a spectrum assignment in the Local Access Licence bands can currently take 4 to 6 months and, in many cases, applications result in an answer of “no”. Additionally, the operators can require significant additional “administration fees” to process the applications and release the spectrum. This all understandably puts off many potential users and is hampering investment.

Getting a spectrum assignment in the Shared Access Licence bands can currently take up to 30 days. This is too long for some users that only wish to make use of the spectrum assignment for a relatively short period of time (e.g. to deploy a private 5G base station at a weekend festival/event) or for last minute requirements (e.g. for a TV production company to deploy a 5G base station to cover at a location where this is a breaking news story).

Dynamic Spectrum Access involves the dynamic assignment of frequencies to different users by a database (instead of a user having a fixed/static frequency all of the time). This allows different users to share the spectrum at different times – and also means that spectrum assignments for a piece of radio equipment can be obtained very quickly (within minutes, if not seconds) from an electronic database.

Automation of the spectrum assignment process will also result in a reduction of complexity and the regulatory burden for spectrum licensees including the mobile operators, in line with the Government’s instructions to regulators to support economic growth[1].

This spectrum sandbox has investigated dynamic access to LAL and SAL spectrum through three work packages:

[1] See UK Government, ‘New approach to ensure regulators and regulation support growth’, 17 March 2025, accessed at https://www.gov.uk/government/publications/a-new-approach-to-ensure-regulators-and-regulation-support-growth

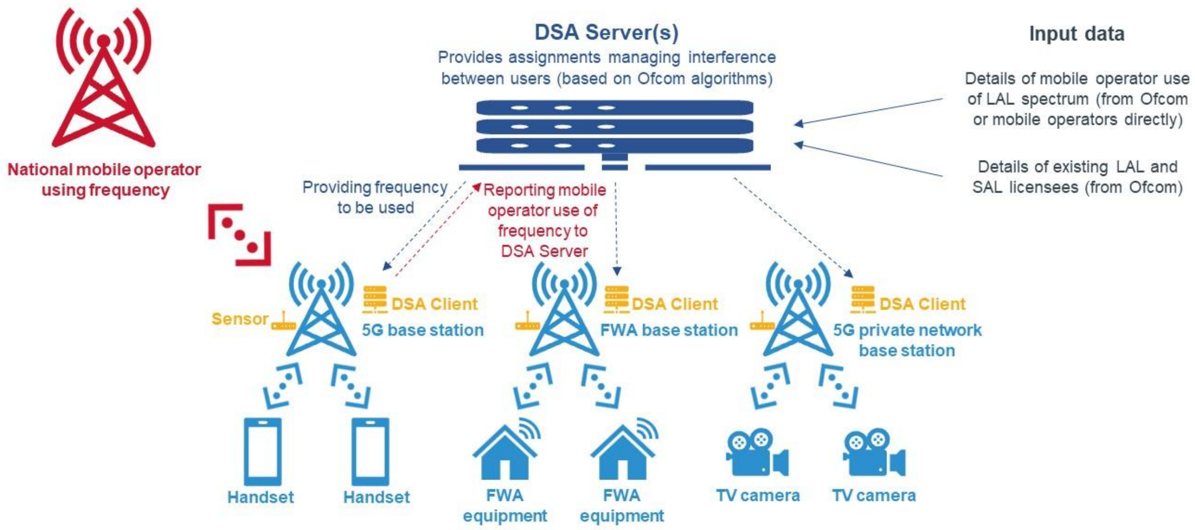
- Work Package 1 has involved the development of a proof-of-concept DSA system (to Technology Readiness Level (TRL) of around 6).
- Work Package 2 has involved simulating the radio environment using advanced ray tracing simulations, aided by machine learning and artificial intelligence.
- Work Package 3 (the subject of this report) has involved estimating the economic benefits of introducing DSA in the LAL and SAL frequency bands and how this could be implemented under the current laws and regulations pertaining to spectrum use in the UK (including an indicative timescale).

The sandbox has demonstrated the concept in a LAL frequency band (1800MHz, also known as Band 3[2]) and in a SAL frequency bands (3.8-4.2GHz, also known as Band n77[3]).

1.2 Overview of the DSA system

Figure 1-1 below provides a simplified illustration of how a DSA system would operate. In summary:

Figure 1-1: Simplified overview of operation of DSA in the LAL and SAL bands



In summary:

- A DSA Server would assign frequencies (and associated parameters) to equipment (e.g. 5G radio base stations) via a DSA Client (middleware to enable communications between the DSA Server and the radio). The assigned frequencies would then be used for communications between the base station and connected devices (e.g. mobile handsets, fixed wireless access terminals on homes, TV cameras). Without a spectrum assignment from the DSA Server, the radio base station would not be licensed to operate.

---

[2] See Wikipedia, 'LTE frequency bands', accessed at https://en.wikipedia.org/wiki/LTE_frequency_bands

[3] See Wikipedia, '5G NR frequency bands', accessed at https://en.wikipedia.org/wiki/5G_NR_frequency_bands. Note that the 3.8-4.2GHz frequency range is part of Band n77 – but being part of this range means that mobile equipment (e.g. handsets) operating in whole of Band n77 support this frequency range.

- The DSA Server would determine spectrum assignments by using coexistence algorithms (defined by Ofcom) to determine the permissible transmit power in each frequency channel that is compatible with the usage conditions for the band and avoids causing harmful interference to existing users.
- Each DSA Server would assign spectrum in both LAL and SAL bands. It is envisaged there would be multiple DSA Servers, provided by industry in a competitive market[4], which may need to exchange some information to ensure consistency.
- For operations in LAL bands:
  - The mobile operator holding national rights to the spectrum would have highest priority followed by any existing LAL users and the users with dynamic spectrum assignments would have the third level of priority.
  - Inputs on the usage of spectrum by the national mobile operators in the LAL bands would be provided by Ofcom and/or the national mobile operators directly, making timely account of ongoing changes. Inputs on existing LAL licences would come from Ofcom.
  - A base-station using a LAL band is required to immediately discontinue using a frequency channel if the licensed mobile operator begins using that channel in the vicinity. The base-station, or its controlling software, must automatically maintain contact with the DSA Server to receive instructions to discontinue, or to 'hop' onto a different spectrum assignment.
- For operations in SAL bands:
  - Any pre-existing assignments made to existing users of the spectrum (e.g. satellite, fixed links) would be protected from harmful interference and allowed to cause harmful interference to new users. This protection does not apply to any new assignments to these users – or changes to their current assignments. Existing SAL assignments and new SAL assignments would be treated equally on a first-come, first served basis.
  - Inputs on the usage of spectrum by other SALs, and other licensees (e.g. fixed point-to-point links) in the SAL bands, would be provided by Ofcom.
  - A base-station using a SAL band has no need to react immediately to ongoing changes in others' usage. A human may obtain a spectrum assignment from the DSA Server via a web page and manually configure the base-station to use it. An automated approach may also be used if the particular devices have the capability.
- Any radio equipment connected to the database (e.g. 5G private base station) could also be equipped with sensors to determine the nearby usage by priority users (e.g. mobile operators in the LAL bands) and feed this information to the DSA Server. This enables a "Coordinated Detect & Avoid" mechanism, whereby the DSA Server combines measurements – from all devices from all licensees – with the inputs provided by Ofcom and mobile operators to form an accurate and up-to-date picture of nearby usage in the frequency band, and to react immediately to any changes. This could also enable the algorithms used in the DSA Server to not be overly conservative in respect of predicting interference, since there would be a further interference protection mechanism in specific locations where the existing (priority) user signals travelled further/are higher in signal strength than predicted by the algorithms.

---

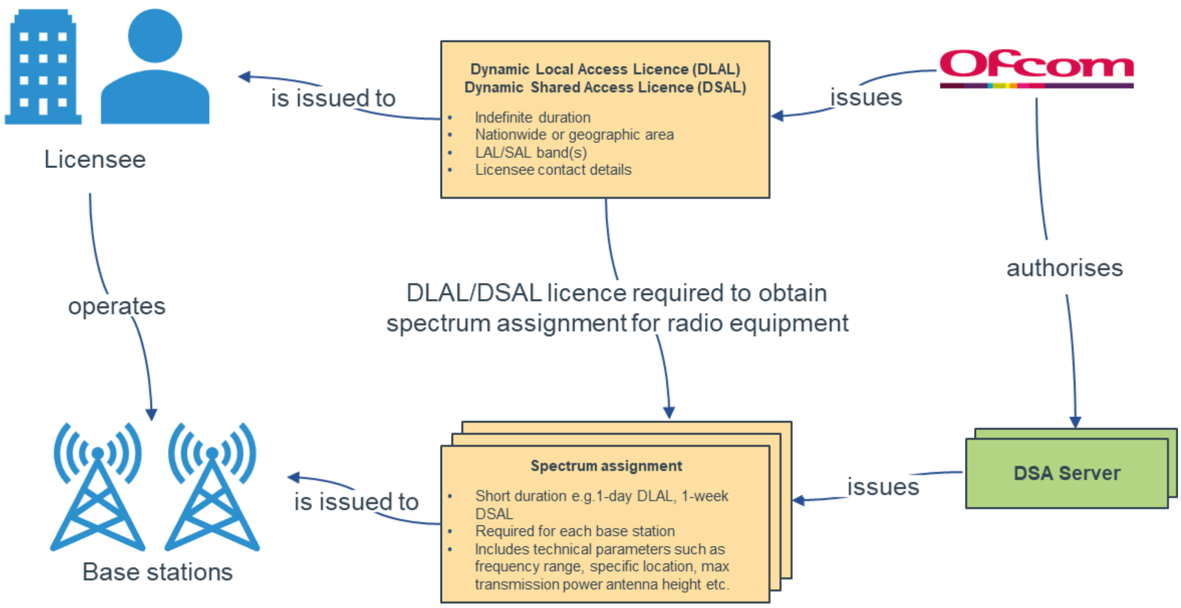
[4] This is a similar approach to that proposed by Ofcom for introducing DSA in the 6GHz band – see Ofcom, 'Expanding access to the 6 GHz band for mobile and Wi-Fi services: Proposals for AFC in Lower 6 GHz and mobile / Wi-Fi sharing in Upper 6 GHz: Consultation', 13 February 2025.

Full details of how dynamic spectrum assignment would operate can be found in Deliverable 1.2 from this sandbox, entitled 'Proposed Spectrum Sharing Solution'[5].

At all times, a hierarchy of users would be respected. In the case of LALs, the mobile operator holding national rights[6] to the spectrum would have highest priority followed by any existing LAL users and the users with dynamic spectrum assignments would have the third level of priority. In the case of SALs, any pre-existing assignments made to existing users of the spectrum (e.g. satellite, fixed links) would be protected from harmful interference and allowed to cause harmful interference to new users. This protection does not apply to any new assignments to these users – or changes to their current assignments. Existing SAL assignments and new SAL assignments would be treated/made on a first-come, first served basis.

At present, usage in LAL and SAL bands is licensed (as opposed to licence-exempt etc.). We propose to maintain this licensed approach and enable DSA by separating the licensing process from the spectrum assignment process. All users of DSA in the LAL or SAL frequency bands would require an administrative licence from Ofcom – a Dynamic Local Access Licence (DLAL) or a Dynamic Shared Access Licence (DSAL). These licences enable the same enforcement mechanisms and day-to-day operational relationships as the existing LALs and SALs. Unlike LALs, and SALs, however, they are not limited to specific sites, radios, technical parameters (e.g. transmit power, antenna height, etc.), or spectrum assignments. The licence permits spectrum usage only when a spectrum assignment is later obtained from a DSA Server. This is illustrated in Figure 1-2 below.

Figure 1-2: Overview of dynamic access licensing model



1.3 Economic assessment

To assess the **incremental** economic benefits of introducing DSA for Local Area Licences and Shared Access Licences, we compared two scenarios:

---

5 QMUL Spectrum Sandbox, 'Proposed Spectrum Sharing Solution', Version 1.0, 31 October 2024.

6 We note there may be certain geographic areas where other users (e.g. defence) may have priority over the mobile operators and other commercial priority users and these rights would continue to be respected by the DSA Server when making assignments.

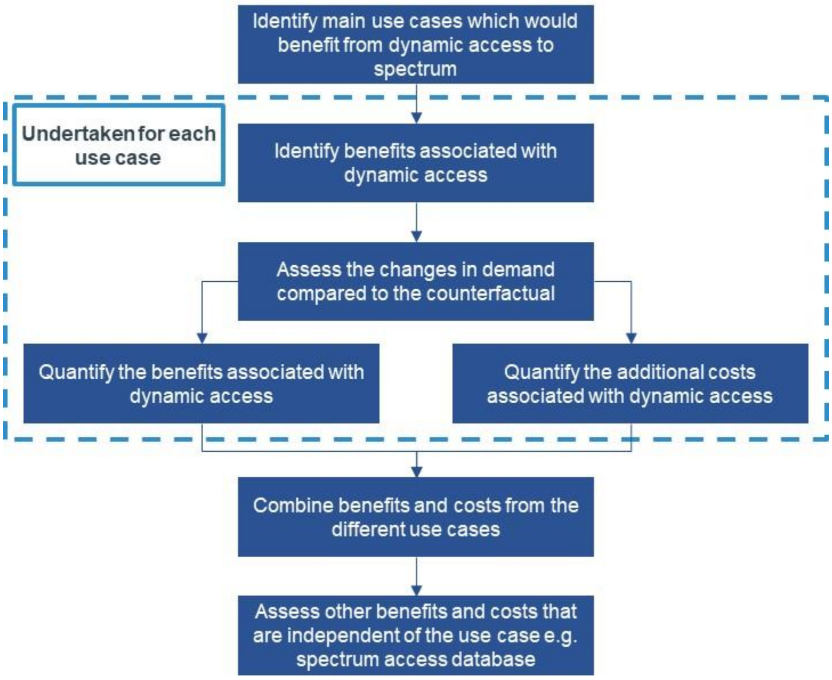
- Dynamic spectrum access is implemented in LAL and SAL spectrum bands (factual scenario)
- LAL and SAL continue under the current framework[7] (counterfactual scenario).

We identified five example use cases which benefit from DSA and estimated the incremental benefits and costs associated with each use case. From this, we then calculated the net incremental benefit that DSA to LAL and SAL spectrum provides to each of the use cases. We then considered the cost associated with the implementation and operation of the DSA Server less any manpower costs that could be saved from automating the existing licensing processes.

Finally, we derived the overall incremental economic benefit from introducing DSA in the LAL and SAL frequency bands by subtracting the above costs from the total net economic benefit of the use cases.

An illustration of our approach is shown in Figure 1-3 below.

Figure 1-3: Overview of approach to assessing net economic benefits of introducing DSA to the LAL and SAL frequency bands



The five use cases considered in our assessment were as follows:

- **Use case 1: Local mobile coverage**. Smaller mobile operators (such as Telet) wishing to provide 'infill' mobile coverage in areas where coverage from the national mobile operators is poor or non-existent would be able to have spectrum assignment decisions made very quickly. The current 4-6 months required and the likelihood of the answer being "no" (even where spectrum is currently available) is a major barrier to investment at present. DSA could generate a wave of investment in providing mobile coverage in areas which are poorly covered at present.

- **Use case 2: Extending Fixed Wireless Access coverage**. Local providers of fixed wireless access services would benefit from access to additional frequency bands including lower frequency spectrum which enables greater number of premises to be covered from a single base station. This may make it economically viable to provide FWA services to some of the 'very hard to reach'

[7] The 'current framework' in this context includes the changes implemented/to be implemented by Ofcom as detailed in Ofcom's December 2024 Statement – see Ofcom, 'Enhancing the Shared Access framework: Statement on further measures to support licensees and enable new use cases: Statement', 2 December 2024.

premises[8] at a lower cost than the subscription and equipment fees for a satellite broadband service. As for local mobile coverage, the current process for obtaining spectrum assignments is likely to be constraining investment in this use case.

- **Use case 3: Additional capacity for national mobile operators**. There are some towns where only a subset of the mobile operators provide 5G coverage. If those operators providing coverage could make use of the spectrum of the other mobile operators whilst it is not being used, this could provide better quality of service to the customers of those mobile operators at a low incremental cost. Additionally, this may then stimulate the operators' not using the spectrum to move to provide 5G coverage in the towns that would otherwise have been the case.

- **Use case 4: Short-term assignments for events**. There are many outdoor low to mid-scale outdoor events and festivals where users suffer from poor mobile connectivity as a result of being in an area with poor mobile coverage or limited mobile capacity that is insufficient to address the 'surge' caused by the event and a temporary private 5G network solution would be beneficial. DSA would increase the viability of such solutions from smaller operators (the current LAL and SAL licensing regime is not designed to provide assignments on a short-term basis (e.g. over a weekend). One specific example of the benefits is that of providing a reliable communications channel for point-of-sales card terminals to be used at the event/festival.

- **Use case 5: Short-term assignments for TV content production**. The broadcasting industry has requested DSA to enable them to better cover major events, breaking news stories and lower tier sports[9]. This would be through using a private 5G network at each location to connect multiple cameras which would either save the costs of running extensive cabling or allow multiple cameras to be used creating a better viewer experience. At present, the spectrum assignment process is not designed for such events – especially for breaking news where rapid access to a spectrum assignment would be needed (during the time taken to physically travel to the location).

We have undertaken a qualitative assessment of the benefits and costs associated with each of the above use cases and have been able to quantify many, but not all, of the benefits as well as the costs. As summary of our estimate of the net benefit (benefits less costs) of each use case is shown in Figure 1-4 below. It can be seen that the total net benefit from all use cases is around GBP105 million in net present value terms over the period 2025-2036 (covering the R&D initial development time and expected asset lifetime) discounted to 2024-25 using a social discount rate of 3.5% as recommended by HM Treasury Green Book[10]. In view of the uncertainties over our underlying assumptions including take-up rates, we have undertaken a sensitivity analysis of the net benefits to key variables – this can be found in our main report. Nonetheless we stress all estimates of value have a range of uncertainty and should be taken as ballpark estimates of the economic benefit rather than precise calculations.

Taking account of the sensitivity analysis on key assumptions, the value of the total net benefit from all of the five use cases is estimated to be in the range of GBP60 to 165 million.

---

[8] DSIT, 'Digital Connectivity: Consultation on Improving Broadband for Very Hard to Reach', October 2023.

[9] See, for example, 'BBC response to the Ofcom consultation: Expanding Access to Shared Spectrum', 18 September 2024, accessed at https://www.ofcom.org.uk/siteassets/resources/documents/consultations/category-1-10-weeks/consultation-supporting-increased-use-of-shared-spectrum/responses-2/bbc.pdf?v=384206

[10] HM Treasury, 'Green Book supplementary guidance: discounting', 2022.

Figure 1-4: Summary of benefits of each use case under base case assumptions

Use case	Total value 2025-2036 (GBP million)	Net present value 2025-2036 (GBP million)	Range of NPV 2025-2036 (GBP million)
Local mobile coverage	95.0	67.4	37.2 - 67.4
Extending the reach of fixed wireless access (FWA)	11.8	4.8	0.2 - 50.4
Additional capacity for national mobile operators	0.6	0.5	0.1 - 0.9
Short-term assignments for events[11]	7.2	5.5	2.8 - 8.3
Short-term assignments for TV content production	38.0	29.3	21.9 - 36.6
Total	**152.7**	**107.6**	**62.3 – 163.6**

We have considered the main costs associated with implementing DSA in the LAL and SAL bands. These are summarised in Figure 1-5 below. It can be seen that the costs amount to around GBP25 million in net present value terms.

Figure 1-5: Summary of costs for implementing DSA

Category of expense	Total cost 2025-2036 (GBP million)	Net present value 2025-2036 (GBP million)
Development of the required regulatory framework	0.9	0.9
Development and running of the DSA Server	27.7	21.4
Middleware for radio to DSA Server communication	2.6	2.4
Additional ongoing staffing costs for Ofcom	-	-
Total	**31.2**	**24.7**

[11] We also separately considered the benefits that may arise from the national mobile operators being able to use SALs to provide 'surge' capacity at events. This is discussed in Annex B of this report.

1.4 Regulatory implementation

The use of radio communications equipment is authorised under the Wireless Telegraphy Act 2006 which specifies that radio equipment cannot be installed or used in the UK except under the authority of a licence granted by Ofcom, or otherwise exempted by regulations made by Ofcom. Equipment must meet the minimum requirements set out in the UK Interface Requirement that applies to the stated frequency band and equipment type.

We believe that the proposed licensing framework for dynamic access to LAL and SAL spectrum bands can be implemented under Ofcom's existing powers under the Wireless Telegraphy Act. We would expect that Ofcom would need to prepare a detailed consultation document, undertake the consultation including a detailed review of responses and then prepare a final Statement. This would then lead to the updating of guidance notes for the local access and shared access licensing regimes as well as any updates to the Interface Requirements for each relevant frequency band.

Our proposals for the scope, duration and fees for DLAL/DSAL licences and spectrum assignments are set out in Figure 1-6 below.

Figure 1-6: Scope, duration and fees for DLAL/DSAL licences and spectrum assignments

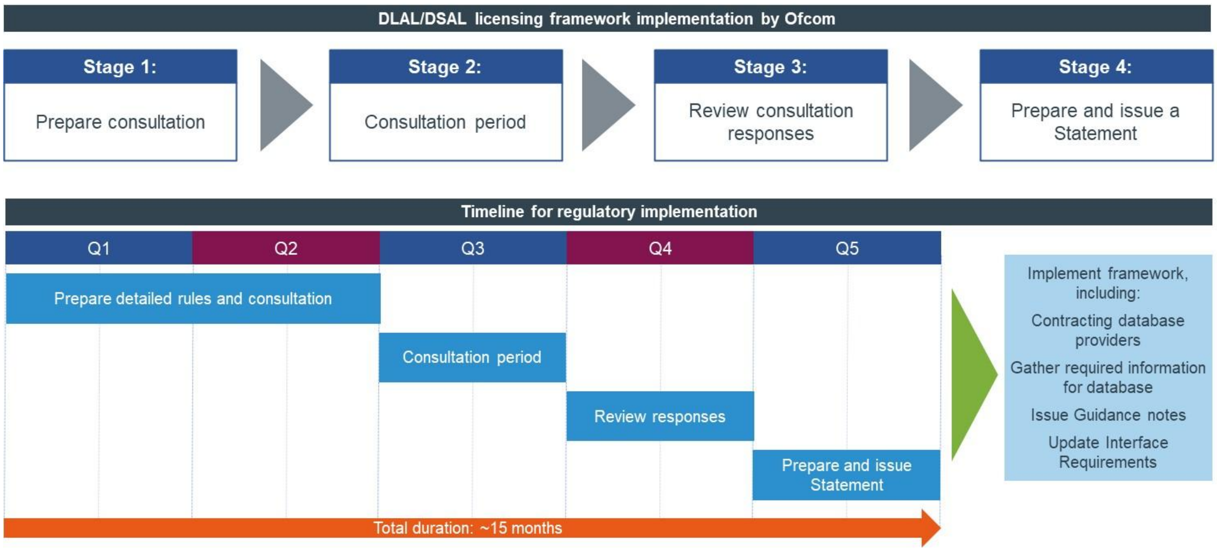
	DLAL / DSAL licence	Dynamic spectrum assignment
Scope	Licences could be either **national** or **sub-national** areas Would cover multiple pieces of equipment/allow multiple assignments	Spectrum assigned for an individual device at a **specific geo-location**
Duration	Licences could last indefinitely (unless revoked)	Dynamic spectrum assignment period would be specified as part of the DLAL/DSAL rules (e.g. 24 hours)
Fees	One-time small administrative fee paid to Ofcom per DLAL or DSAL licence (set on a cost-recovery basis)	Fee to be determined by DSA server providers

Figure 1-7 comprises an illustrative timeline for the regulatory implementation which involves the following key stages:

- Stage 1: Preparation of detailed rules/regulatory framework and consultation document (~6 months)
- Stage 2: Consultation period (~3 months)
- Stage 3: Review of consultation responses and update regulatory framework (~3 months)
- Stage 4: Prepare and issue Statement (~ 3 months).

This would amount to a total duration of around 18 months. In parallel with the regulatory implementation, further prototyping of the proposed solution could continue, building on the development work undertaken in Work Packages 1 and 2 of this sandbox.

Figure 1-7: Indicative timeline for regulatory implementation



Following the implementation of the regulatory environment, the detailed implementation could proceed including contracting database providers (who we envisage would have commenced R&D work during Stages 3 and 4 of the regulatory process) and finalising all the appropriate regulations and guidance notes.

There could be a further stage of implementation whereby certain equipment could be authorised to operate on a licence-exempt basis (for example, similar to the General Authorised Access regime for CBRS in the USA). This could be, for example, to allow low power radio equipment that is certified as meeting certain specific requirements (for example for the radio equipment to be able to provide an accurate geolocation automatically) to operate in the LAL and SAL spectrum bands without requiring a DLAL or DSAL licence – but it would require a spectrum assignment from a DSA Server. The implementation of licence-exempt access to DLAL and DSAL spectrum could draw upon the framework previously used for TV White Space devices in the UK whereby a DLAL/DSAL-specific licence exemption regulation would be issued to cover such low-power uses (i.e. to make the equipment exempt from requiring a licence under the Wireless Telegraphy Act). This could be implemented in second phase if and when relevant use cases are identified.

1.5 Conclusions

Our economic assessment has estimated that around GBP80 million of net benefit (net present value over the period 2025-2036, discounted to 2024-25) could be realised for the UK economy through the implementation of DSA in the LAL and SAL frequency bands.

Taking account of the uncertainties over key assumptions used in our estimations of the benefits of individual use cases, we note that the overall net benefit could range from around GBP35 million to GBP140 million (net present value 2025-2036, in 2024/2025 terms).

Furthermore, this is a quantitative estimate of the benefits based on assessing five potential use cases. There could be other use cases that we have not considered – and, furthermore, those five use cases have wider benefits that are not quantifiable (for example improved television viewer experience, promotion of lower tier sports).

We therefore recommend DSIT and Ofcom proceed with introducing DSA to the LAL and SAL bands. We believe that this can be undertaken using Ofcom's existing powers under the Wireless Telegraphy

Act 2006 and an 18 month process would be required to develop, consult on and finalise new regulations.

DSA is very much the future of spectrum management, and it is important for the UK to take a leading position in this area. We are pleased that Ofcom has recently published proposals for introducing DSA in the 6GHz band[12] and we believe that there will be synergies between this and enabling DSA in the LAL and SAL bands in terms of development costs, but more than this it will place the UK in a leading position in terms of early adoption of DSA and the wider economic benefits to the UK economy that arise from this. Over time the benefits of introducing DSA across multiple spectrum bands could amount to as much as GBP2.5 billion per annum (based on a conservative assumption that introducing DSA would yield around a 5% increase in the economic value realised from spectrum in the UK).

[12] See Ofcom, 'Expanding access to the 6 GHz band for mobile and Wi-Fi services: Proposals for AFC in Lower 6 GHz and mobile / Wi-Fi sharing in Upper 6 GHz: Consultation', 13 February 2025.

2. Introduction

This report has been prepared by Aetha Consulting Limited (Aetha) as a summary of an assessment of the economic benefits and approach required for regulatory implementation of dynamic access to spectrum in the Local Access Licence (LAL) and Shared Access Licence (SAL) frequency bands in the United Kingdom.

This work has been undertaken as part of a wider ‘spectrum sandbox’ undertaken for the Department of Science, Innovation and Technology (DSIT) by a consortium comprising Queen Mary University of London (QMUL), the lead partner, and Telet Research Limited (Telet), Federated Wireless and Aetha.

2.1 Background – the importance of dynamic spectrum access

The radio spectrum is estimated to contribute over GBP50 billion a year to the UK economy[13]. It is a scarce resource and use of the spectrum is becoming increasingly extensive – in particular individual frequency bands need to be shared between multiple uses.

One innovative approach for increasing the sharing of spectrum (and thereby the economic value derived from its use) is the dynamic assignment of spectrum to different users by a database (instead of a user having a fixed/static frequency all of the time). This allows different users to share the spectrum at different times – and also means that spectrum assignments for a piece of radio equipment can be obtained very quickly (within minutes, if not seconds) from an electronic database compared to the current administrative processes which can take weeks if not months.

Dynamic Spectrum Access (DSA) has been used in the USA to allow sharing of spectrum used by the US military (and other existing users) with new users of 4G and 5G mobile technology (including both the public mobile operators) and also for private 4G/5G networks. It is also being used in the USA to assign spectrum for Wi-Fi users in the 6GHz band, sharing with existing satellite and fixed microwave link users. Essentially DSA is enabling new users of the spectrum to co-exist alongside existing uses, thereby significantly increasing the economic value derived from the spectrum bands in which it has been implemented. Over the next 30 years, it is likely that large swathes of radio frequencies will be managed in this way to enable greater spectrum sharing, which in turn facilitates new uses and technologies which support economic growth.

It is therefore important that the UK plays a leading role in implementing DSA systems. The UK was one of the pioneers of a first system – TV White Space spectrum – however for various reasons (including a very limited equipment ecosystem) this did not succeed, and the supporting databases were fully closed down in 2024.

2.2 Scope of the spectrum sandbox

Our spectrum sandbox explores the introduction of DSA to Local Access Licence (LAL) and Shared Access Licence (SAL) bands:

- Local Access Licence bands are frequency bands which have been assigned to the national mobile operators but there is potential for other organisations to make use of individual frequencies where they are not being used by the mobile operator to whom they are licensed.

[13] See estimates of the economic contribution of spectrum in DSIT, ‘Spectrum statement’, 11 April 2023.

- Shared Access Licence bands are intended for shared use by medium and lower-power users (for example local private 4G/5G networks) and the spectrum is also shared with existing users in each band (e.g. satellite, defence).

These frequency bands are mostly already supported in mass market devices (e.g. mobile handsets) which is the main benefit of using the bands for new applications which can benefit from the existing economies of scale.

The main challenge with Local Access Licence bands is that permission needs to be obtained from the mobile operator to use the spectrum – this process (which is conducted through Ofcom) can take 4 to 6 months and, in many cases, applications result in an answer of "no" on the basis that the mobile operator might want to use the frequencies at a future date. Additionally, the operators can require significant additional "administration fees" to process the applications and release the spectrum. This all understandably puts off many potential users and is hampering investment. Our proposed dynamic access approach would by default allow a new user to immediately make use of frequencies in areas where they are not used by the mobile operator and where they would not cause harmful interference to the reception of signals from the mobile operator. If/when the mobile operator subsequently needs to use the spectrum, the dynamic access user would be moved to a new frequency to avoid disrupting the mobile operator's use of the spectrum which would also have priority.

Likewise, a similar timing challenge arises with the Spectrum Access Licence bands in that licence applications can take up to 30 days to process. For some users that would benefit from using the spectrum for a short period (e.g. to deploy a private 5G base station at a weekend festival/event) or for last minute requirements (e.g. for a TV production company to deploy a 5G base station to cover at a location where this is a breaking news story), this timescale is too long. Dynamic access would result in a spectrum assignment being made in minutes (if not seconds). Furthermore, one constraint on the use of existing SAL bands is that the base stations need to be using a common synchronisation of transmissions with time. This common synchronisation is not ideal for some uses (e.g. uploading vide from wireless cameras to a private 5G base station generates a lot of uplink traffic and little downlink traffic – the opposite of conventional mobile use). A dynamic spectrum assignment process can take account of different synchronisations and make spectrum assignments accordingly (e.g. by increasing separation distances between equipment using different synchronisations).

It can be seen that enabling dynamic access to LAL and SAL spectrum bands could enable new uses of the spectrum with resulting economic benefits for both the specific users/organisations concerned and also wider benefits to the local economy and society.

Automation of the spectrum assignment process will also result in a reduction of complexity and the regulatory burden for spectrum licensees including the mobile operators, in line with the Government's instructions to regulators to support economic growth[14].

The spectrum sandbox has investigated dynamic access to LAL and SAL spectrum through three work packages:

- **Work Package 1** has involved the development of a proof-of-concept system (to Technology Readiness Level (TRL) of around 6). This has involved developing a DSA Server to issue spectrum assignments and customising a series of 4G and 5G radios to communicate with it to obtain spectrum assignments and cease/release transmissions if/when mobile operator usage of the band is detected.

[14] See UK Government, 'New approach to ensure regulators and regulation support growth', 17 March 2025, accessed at https://www.gov.uk/government/publications/a-new-approach-to-ensure-regulators-and-regulation-support-growth

- **Work Package 2** has involved simulating the radio environment using advanced ray tracing simulations, aided by machine learning and artificial intelligence. This enables better prediction of both spectrum availability and the interference environment between different types of users and would ultimately help the DSA Server make better/more informed spectrum assignments to users.

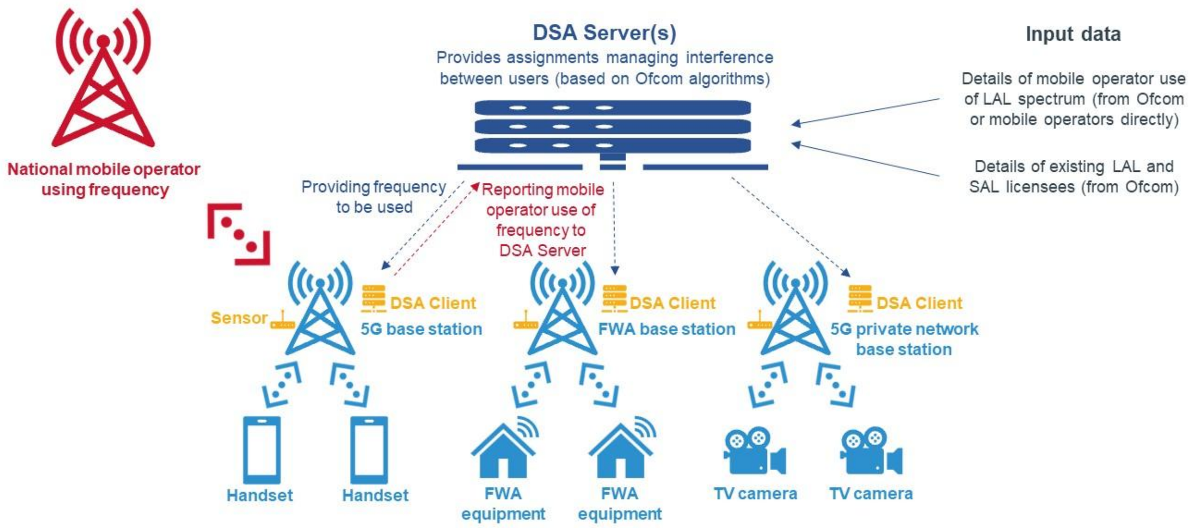
- **Work Package 3** (the subject of this report) has involved estimating the economic benefits of introducing DSA to the LAL and SAL bands, drawing upon the measurement and simulation data collated in Work Packages 1 and 2. Additionally this work package has investigated how dynamic access to LAL and SAL spectrum bands could be implemented under the current laws and regulations pertaining to spectrum use in the UK and proposed a timescale for this.

The sandbox has demonstrated the concept in a LAL frequency band (1800MHz, also known as Band 3[15]) and in a SAL frequency bands (3.8-4.2GHz, also known as Band n77[16]).

2.3 Overview of the DSA system

Figure 2-1 below provides a simplified illustration of how a DSA system would operate.

Figure 2-1: Simplified overview of operation of DSA in the LAL and SAL bands



In summary:

- A DSA Server would assign frequencies (and associated parameters) to equipment (e.g. 5G radio base stations) via a DSA Client (middleware to enable communications between the DSA Server and the radio). The assigned frequencies would then be used for communications between the base station and connected devices (e.g. mobile handsets, fixed wireless access terminals on homes, TV cameras). Without a spectrum assignment from the DSA Server, the radio base station would not be licensed to operate.

---

[15] See Wikipedia, 'LTE frequency bands', accessed at https://en.wikipedia.org/wiki/LTE_frequency_bands

[16] See Wikipedia, '5G NR frequency bands', accessed at https://en.wikipedia.org/wiki/5G_NR_frequency_bands. Note that the 3.8-4.2GHz frequency range is part of Band n77 – but being part of this range means that mobile equipment (e.g. handsets) operating in whole of Band n77 support this frequency range.

- The DSA Server would determine spectrum assignments by using coexistence algorithms (defined by Ofcom) to determine the permissible transmit power in each frequency channel that is compatible with the usage conditions for the band and avoids causing harmful interference to existing users.
- Each DSA Server would assign spectrum in both LAL and SAL bands. It is envisaged there would be multiple DSA Servers, provided by industry in a competitive market[17], which may need to exchange some information to ensure consistency.
- For operations in LAL bands:
  - The mobile operator holding national rights to the spectrum would have highest priority followed by any existing LAL users and the users with dynamic spectrum assignments would have the third level of priority.
  - Inputs on the usage of spectrum by the national mobile operators in the LAL bands would be provided by Ofcom and/or the national mobile operators directly, making timely account of ongoing changes. Inputs on existing LAL licences would come from Ofcom.
  - A base-station using a LAL band is required to immediately discontinue using a frequency channel if the licensed mobile operator begins using that channel in the vicinity. The base-station, or its controlling software, must automatically maintain contact with the DSA Server to receive instructions to discontinue, or to 'hop' onto a different spectrum assignment.
- For operations in SAL bands:
  - Any pre-existing assignments made to existing users of the spectrum (e.g. satellite, fixed links) would be protected from harmful interference and allowed to cause harmful interference to new users. This protection does not apply to any new assignments to these users – or changes to their current assignments. Existing SAL assignments and new SAL assignments would be treated equally on a first-come, first served basis.
  - Inputs on the usage of spectrum by other SALs, and other licensees (e.g. fixed point-to-point links) in the SAL bands, would be provided by Ofcom.
  - A base-station using a SAL band has no need to react immediately to ongoing changes in others' usage. A human may obtain a spectrum assignment from the DSA Server via a web page and manually configure the base-station to use it. An automated approach may also be used if the particular devices have the capability.
- Any radio equipment connected to the database (e.g. 5G private base station) could also be equipped with sensors to determine the nearby usage by priority users (e.g. mobile operators in the LAL bands) and feed this information to the DSA Server. This enables a "Coordinated Detect & Avoid" mechanism, whereby the DSA Server combines measurements – from all devices from all licensees – with the inputs provided by Ofcom and mobile operators to form an accurate and up-to-date picture of nearby usage in the frequency band, and to react immediately to any changes. This could also enable the algorithms used in the DSA Server to not be overly conservative in respect of predicting interference, since there would be a further interference protection mechanism in specific locations where the existing (priority) user signals travelled further/are higher in signal strength than predicted by the algorithms.

[17] This is a similar approach to that proposed by Ofcom for introducing DSA in the 6GHz band – see Ofcom, 'Expanding access to the 6 GHz band for mobile and Wi-Fi services: Proposals for AFC in Lower 6 GHz and mobile / Wi-Fi sharing in Upper 6 GHz: Consultation', 13 February 2025.

Full details of how dynamic spectrum assignment would operate can be found in Deliverable 1.2 from this sandbox, entitled 'Proposed Spectrum Sharing Solution'[18].

At all times, a hierarchy of users would be respected. In the case of LALs, the mobile operator holding national rights[19] to the spectrum would have highest priority followed by any existing LAL users and the users with dynamic spectrum assignments would have the third level of priority. In the case of SALs, any pre-existing assignments made to existing users of the spectrum (e.g. satellite, fixed links) would be protected from harmful interference and allowed to cause harmful interference to new users. This protection does not apply to any new assignments to these users – or changes to their current assignments. Existing SAL assignments and new SAL assignments would be treated/made on a first-come, first served basis.

At present, usage in LAL and SAL bands is licensed (as opposed to licence-exempt etc.). We propose to maintain this licensed approach and enable DSA by separating the licensing process from the spectrum assignment process. All users of DSA in the LAL or SAL frequency bands would require an administrative licence from Ofcom – a Dynamic Local Access Licence (DLAL) or a Dynamic Shared Access Licence (DSAL). These licences enable the same enforcement mechanisms and day-to-day operational relationships as the existing LALs and SALs. Unlike LALs, and SALs, however, they are not limited to specific sites, radios, technical parameters (e.g. transmit power, antenna height, etc.), or spectrum assignments. The licence permits spectrum usage only when a spectrum assignment is later obtained from a DSA Server.

2.4 Structure of this report

The remainder of this report is structured as follows:

- Section 3 presents an overview of our approach to estimating the economic benefits including modelling parameters and an introduction to five use cases that we evaluated
- Sections 4 to 8 present our evaluation of the benefits of DSA to each of the five use cases in turn
- Section 9 presents our overall assessment of the net benefits (benefits less costs) of introducing DSA in the LAL and SAL frequency bands.
- Section 10 outlines how dynamic access could be implemented from a regulatory perspective including an indicative timeline for implementation
- Section 11 presents our overall conclusions from our assessments.

Two Annexes provide additional supporting information:

- Annex A details our review of existing economic benefits assessment studies of particular reference to several of the use cases considered in this report
- Annex B summarises our economic assessment of a potential additional use case – Use of SAL spectrum by mobile operators at events.

[18] QMUL Spectrum Sandbox, 'Proposed Spectrum Sharing Solution', Version 1.0, 31 October 2024.

[19] We note there may be certain geographic areas where other users (e.g. defence) may have priority over the mobile operators and other commercial priority users and these rights would continue to be respected by the DSA Server when making assignments.

3. Approach to estimating economic benefits and costs

3.1 Overall approach

To assess the **incremental** economic benefits of introducing DSA for Local Area Licences and Shared Access Licences, we compared two scenarios:

- Dynamic spectrum access is implemented in LAL and SAL spectrum bands (factual scenario)
- LAL and SAL continue under the current framework[20] (counterfactual scenario).

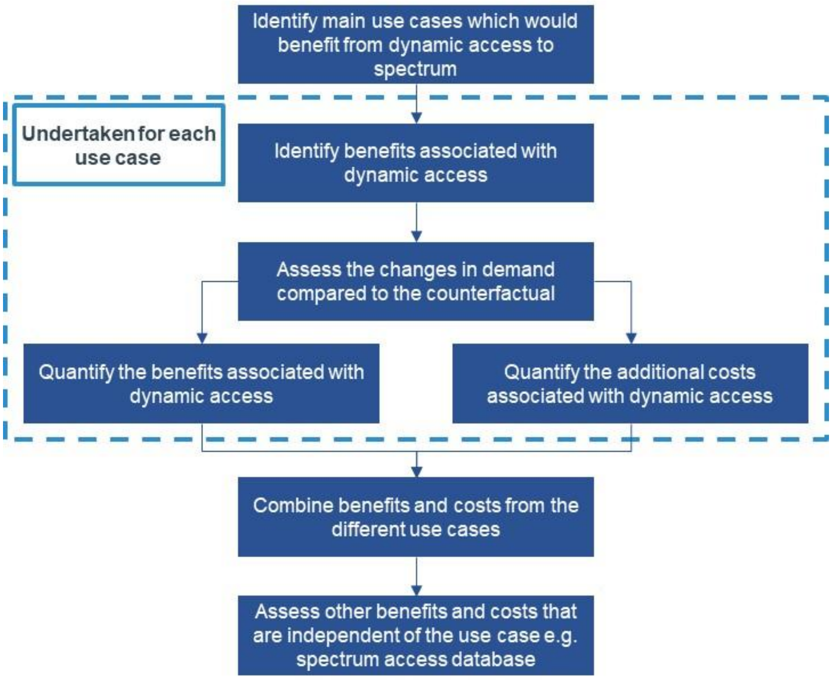
We identified five example use cases which benefit from DSA and estimated the incremental benefits and costs associated with each use case. From this, we then calculated the net incremental benefit that DSA to LAL and SAL spectrum provides to each of the use cases.

We then considered the cost associated with the implementation and operation of the DSA Server less any manpower costs that could be saved from automating the existing licensing processes.

Finally, we derived the overall incremental economic benefit from introducing DSA in the LAL and SAL frequency bands by subtracting the above costs from the total net economic benefit of the use cases.

An illustration of our approach is shown in Figure 3-1 below.

Figure 3-1: Overview of approach to assessing net economic benefits of introducing DSA to the LAL and SAL frequency bands



[20] The 'current framework' in this context includes the changes implemented/to be implemented by Ofcom as detailed in Ofcom's December 2024 Statement – see Ofcom, 'Enhancing the Shared Access framework: Statement on further measures to support licensees and enable new use cases: Statement', 2 December 2024.

In the remainder of this section we present:

- an overview of the five use cases – further details are provided in Sections 4 to 8
- a qualitative assessment of the benefits and costs associated with each use case – in particular since it is impractical to quantify all of the benefits (and some of the costs)
- the key underlying modelling principles and assumptions which underly our quantitative assessment – full details of specific assumptions used for individual use cases and the overall assessment can be found in Sections 4 to 8.

3.2 Introduction to the use cases

As discussed in Section 2.2, the main advantages of introducing DSA for the different types of licences are as follows:

- Local Access Licences: Shortening of the time required to receive a decision on a spectrum assignment from 4-6 months to minutes (if not seconds) and increased likelihood of receiving a "yes".
- Shared Access Licences: Again, shortening the decision time to receive a spectrum assignment to minutes (if not seconds).

We have identified a number of example use cases from which the benefits of dynamic access to LAL and SAL spectrum can be estimated:

- **Use case 1: Local mobile coverage**. Smaller mobile operators (such as Telet) wishing to provide 'infill' mobile coverage in areas where coverage from the national mobile operators is poor or non-existent would be able to have spectrum assignment decisions made very quickly. The current 4-6 months required and the likelihood of the answer being "no" (even where spectrum is currently available) is a major barrier to investment at present. DSA could generate a wave of investment in providing mobile coverage in areas which are poorly covered at present.
- **Use case 2: Extending Fixed Wireless Access coverage**. Local providers of fixed wireless access services would benefit from access to additional frequency bands including lower frequency spectrum which enables greater number of premises to be covered from a single base station. This may make it economically viable to provide FWA services to some of the 'very hard to reach' premises[21] at a lower cost than the subscription and equipment fees for a satellite broadband service. As for local mobile coverage, the current process for obtaining spectrum assignments is likely to be constraining investment in this use case.
- **Use case 3: Additional capacity for national mobile operators**. There are some towns where only a subset of the mobile operators provide 5G coverage. If those operators providing coverage could make use of the spectrum of the other mobile operators whilst it is not being used, this could provide better quality of service to the customers of those mobile operators at a low incremental cost. Additionally, this may then stimulate the operators' not using the spectrum to move to provide 5G coverage in the towns that would otherwise have been the case.
- **Use case 4: Short-term assignments for events**. There are many outdoor low to mid-scale outdoor events and festivals where users suffer from poor mobile connectivity as a result of being in an area with poor mobile coverage or limited mobile capacity that is insufficient to address the 'surge' caused by the event and a temporary private 5G network solution would be beneficial. DSA

[21] DSIT, 'Digital Connectivity: Consultation on Improving Broadband for Very Hard to Reach', October 2023.

would increase the viability of such solutions from smaller operators (the current LAL and SAL licensing regime is not designed to provide assignments on a short-term basis (e.g. over a weekend). One specific example of the benefits is that of providing a reliable communications channel for point-of-sales card terminals to be used at the event/festival.

- **Use case 5: Short-term assignments for TV content production**. The broadcasting industry has requested DSA to enable them to better cover major events, breaking news stories and lower tier sports[22]. This would be through using a private 5G network at each location to connect multiple cameras which would either save the costs of running extensive cabling or allow multiple cameras to be used creating a better viewer experience. At present, the spectrum assignment process is not designed for such events – especially for breaking news where rapid access to a spectrum assignment would be needed (during the time taken to physically travel to the location).

Please note that these use cases are illustrative of the types of additional uses of spectrum that could arise from introducing a DSA regime. Other uses which we have not even thought of may also be stimulated from providing easier access to the spectrum. The use cases should therefore be seen as an illustration of what is possible rather than a definitive description of the demand for the spectrum licences.

The use cases above relate to the use of both LAL and SAL spectrum bands. We highlight in Figure 3-2 which spectrum bands are relevant to each of the five use cases.

Figure 3-2: Use of LAL and SAL spectrum for each use case

	Local Access License (LAL) spectrum bands	Shared Access License (SAL) spectrum bands
1: Local mobile coverage	✓	
2: Extending FWA coverage	✓	23
3: Additional capacity for national mobile operators	✓	
4: Short-term licences for events	✓	✓
5: Short-term licences for TV content production	✓	✓

We provide further details on each of the use cases in Sections 4 to 8 of this report.

[22] See, for example, 'BBC response to the Ofcom consultation: Expanding Access to Shared Spectrum', 18 September 2024, accessed at https://www.ofcom.org.uk/siteassets/resources/documents/consultations/category-1-10-weeks/consultation-supporting-increased-use-of-shared-spectrum/responses-2/bbc.pdf?v=384206

[23] SAL bands are currently being used to provide FWA services, however the main benefit from DSA would be from use of lower frequency LAL bands with high channel bandwidths to make it more economically efficient to provide FWA coverage in less populated areas.

3.3 Qualitative assessment of benefits and costs of each use case

We have undertaken a qualitative assessment of the benefits and costs associated with providing dynamic access to spectrum to each of the five use cases, as well as for the introduction of DSA overall.

The main benefits we identified comprise:

- **Productivity gains:** Enhanced productivity for both individuals and businesses from improved connectivity enables streamlined operations and increased output both directly from high-speed communications links (messaging, video etc) and also indirectly from having access to the wealth of information resources on the Internet/cloud.
- **Social welfare benefits:** Wider access to high-speed connectivity enabled by DSA fosters inclusivity and social participation in education, employment, and general welfare.
- **Competition:** The provision of alternative connectivity solutions can lead to lower costs for end users as well as higher quality of service through stimulating innovation.
- **Investment and innovation:** By lowering the cost and risk associated with obtaining spectrum assignments, DSA will stimulate greater levels of investment into services that make use of LAL and SAL spectrum which in turn stimulates innovation in applications relying on connectivity.
- **Sustainability:** Higher-speed connectivity can lead to sustainability benefits such as reducing the need for travel through online meetings, conduct of transactions etc.
- **Local employment:** Deploying local solutions often requires on-the-ground support, creating opportunities for employment in the areas where these services are introduced. This could particularly benefit regions with limited existing infrastructure.

There are also costs associated with the implementation of dynamic access to LAL and SAL spectrum:

- **Cost of equipment used to provide connectivity services:** for example the upfront and ongoing costs of operating base station sites which will provide mobile coverage and FWA connectivity to premises. Additionally, the radios used will also need to be adapted to communicate with the DSA Server.
- **Sustainability/power:** As well as providing sustainability benefits, there are also environmental costs associated with operating new network equipment such as power required.
- **Cost of the DSA Server(s):** both the upfront costs of research and development and commercialisation and well as ongoing costs.

A summary of our assessment of the main benefits and costs associated with each individual use case is shown in Figure 3-3. We highlight those key benefits and costs that we have been able to quantify in this study using the green (benefits) and red (costs) shading.

Figure 3-3: Summary of assessment of benefits and costs of each use case [green/red shading depicts quantified benefits and costs]

Benefits & costs	Local mobile coverage	Extended Fixed Wireless Access	Additional capacity for national operators	Short-term events	Short-term TV content production
Productivity gains	Benefits to users and region from improved mobile connectivity	Modelled for small number of additional users for limited period of time	From higher mobile speeds for customers in certain areas	Example of increased financial transactions at events	Lower cost of TV production in some cases
Social welfare benefits	Wider societal benefits from improved mobile network speeds/coverage	Modelled for small number of additional users for limited period of time	Not applicable	May lead to increased number of local events	More events covered on TV – may also lead to greater financial viability Higher quality TV output for viewers in some cases
Competition	May encourage neutral host providers	Cost savings for users with FWA broadband instead of satellite	May stimulate other mobile operators to accelerate deployment in areas	Not applicable	Not applicable
Investment and innovation	Enable investment in uncovered areas (captured in productivity gains)	Investment in FWA provision (captured in competition benefits)	Not applicable	Not applicable	New methods for programme making
Sustainability benefits	Could lead to lower levels of travel	Could lead to lower levels of travel. Lower power for customer terminals.	Not applicable	Not applicable	Not applicable
Local employment	Use of local labour	Use of local labour	Not applicable	Increased number of local events	Not applicable
Equipment costs	New mobile sites	New FWA sites On-premises equipment	Not applicable	Transportable radio sites	Transportable radio sites
Sustainability costs	Power costs for additional sites	Power costs for additional sites	Additional power consumption at sites	Not applicable	Increased travel to events by programme makers
DSA Server costs	Development, commercialisation and operation of DSA Server				

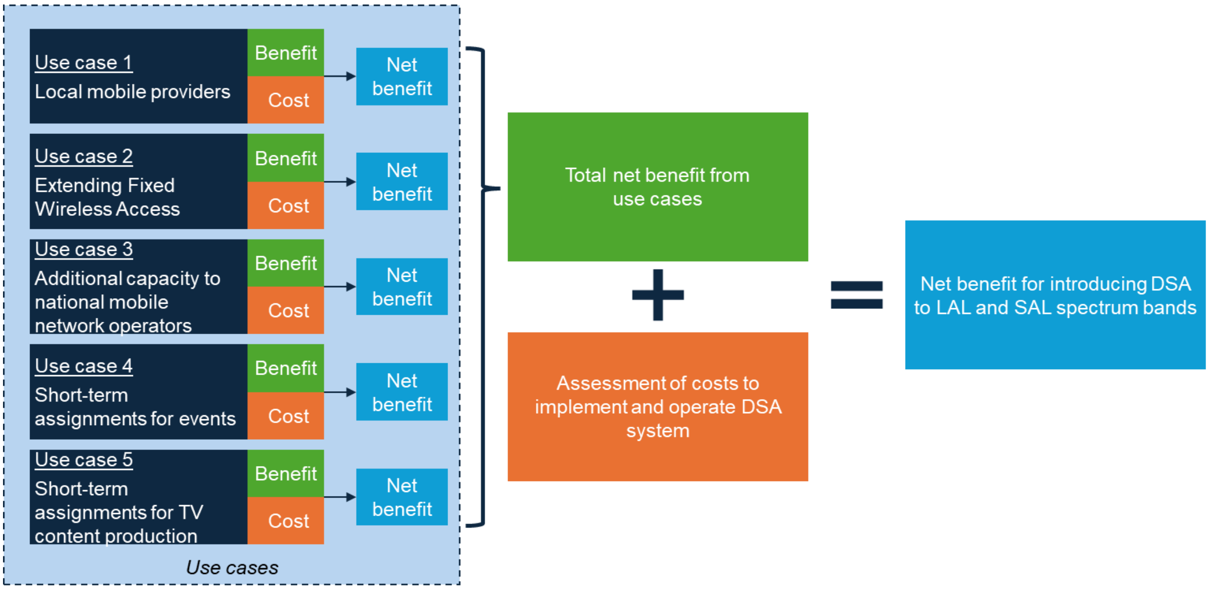
3.4 Principles and assumptions used for quantification

Our quantitative modelling of the economic benefits of introducing dynamic spectrum assignment in the LAL and SAL frequency bands is based on the following principles and assumptions:

- We calculate the economic benefits in net present value (NPV) terms, discounted to 2024-25, using a social discount rate of 3.5% as recommended by HM Treasury Green Book[24].
- We model each use case over a 12-year period from 2025-2036 to reflect an initial R&D/regulatory implementation period of 2 years followed by reasonable asset lifetime of 10 years (this can be extended if required by DSIT).
- There are uncertainties over several of the potential use cases e.g. in terms of take-up levels and also the benefits that are realised and so:
  - We model a base case for each use case and also undertake sensitivity analysis to show how the benefits may change.
  - Nonetheless all estimates of value have a range of uncertainty and should be taken as ballpark estimates of the economic benefit rather than precise calculations.
- Two key inputs into several of our assessments are existing mobile network coverage and LAL/SAL spectrum availability. These have been derived from the measurements and modelling undertaken in Work Packages 1 and 2 of the sandbox.

Our overall approach to assessing the net benefits of each use case and comparing these with the overall costs of implementation of DSA in the LAL and SAL spectrum bands is shown in Figure 3-4 below.

Figure 3-4: Summary of approach to quantifying net benefits of DSA in LAL and SAL spectrum bands



Further details of the assessment of the benefits and costs associated with each use case can be found in Sections 4 to 8 of this report. Each section includes an introduction to the use case, details of the

[24] HM Treasury, 'Green Book supplementary guidance: discounting', 2022.

methodology we have used to assess the benefits and costs associated with the use case and finally details of the results of the analysis including a sensitivity analysis of key assumptions.

4. Use case 1: Local mobile coverage

4.1 Introduction

Local mobile coverage is a focus on delivering connectivity to areas that are either not served by the national operators or are served with a low quality of service, leading to dropped calls and slow and unreliable data connectivity (which may prevent the use of devices such as sensors which require mobile connectivity).

We expect that local mobile coverage will be provided by smaller organisations (local mobile providers) who can more cost-effectively address localised poor coverage spots. Some current examples of providers of local mobile coverage include Telet, Freshwave and Dense Air.

By focusing on challenging environments, including rural regions, temporary venues, and urban zones with poor signal quality, local mobile providers bridge critical connectivity gaps, enhancing digital inclusivity and supporting government goals for widespread mobile access. Some of the challenges addressed by these providers are:

- **Economic barriers in remote areas:** National mobile operators often avoid deploying infrastructure in rural regions due to low returns on investment. Local mobile providers step in to deliver cost-effective solutions, ensuring these areas are not left behind in the digital age.
- **Poor coverage in specific areas:** Despite extensive urban and rural network footprints of the national mobile operators, certain areas at the edges of existing cells experience inadequate user experience. This can affect both indoor and outdoor locations, where connectivity may fall short of acceptable quality-of-service standards. Local providers can enhance service in these zones by deploying targeted solutions, such as small cells, to improve signal strength and reliability.

Local mobile providers can provide connectivity in two different ways:

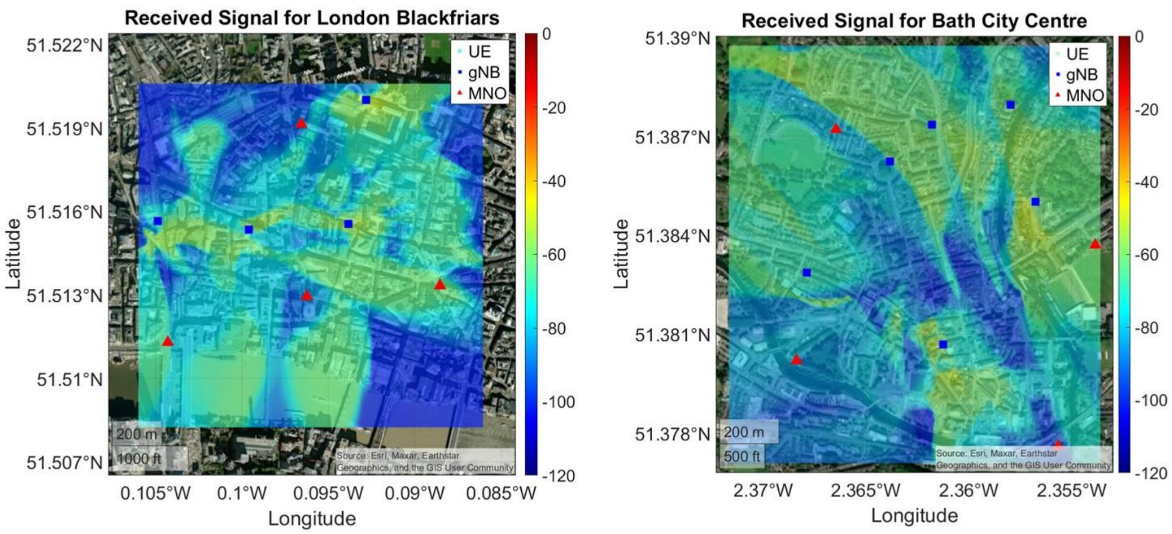
- **Direct services to end customers:** Providing connectivity directly to consumers and businesses that are currently in areas not covered or poorly covered by the mobile operators.
- **Neutral-host infrastructure:** Providing equipment that supports use by one or more of the national mobile operators, thereby allowing the national mobile operators to enhance their network coverage in a cost-effective way. In this case, services are provided to end customers using the spectrum of the national mobile network operators. The national mobile operators could also share spectrum with each other (as well as sharing the radio equipment), thereby providing a further efficiency gain.

For direct services to end customers, local mobile providers typically seek to use local access licences (LALs) since consumer handsets already support these frequency bands as they are being used by the national mobile operators. Additionally access to lower frequency spectrum (compared to SAL frequency bands, for example) means that larger areas can be covered from a single base station site and there is deeper indoor coverage. Furthermore, we understand that device profiles provided by the national mobile operators result in the devices (e.g. mobile handsets) only scanning the mobile bands used by the mobile operators for a signal (to reduce the time required for scanning). As a result, they do not scan several of the SAL bands including the 3.8-4.2GHz range (upper part of Band n77). For these reasons, access to local access spectrum which is used by the national mobile operators is valuable to local access providers seeking to provide services directly to end customers.

As discussed previously, the main challenge with the existing local access licensing framework is that it can take 4-6 months to receive an answer on whether a spectrum assignment can be made in a given location – and often the answer is “no” and the process needs to begin again with an alternative frequency perhaps from the spectrum assigned to a different national mobile operator. This long approval time has a huge negative impact on the business case for local mobile service providers and therefore on investment – despite in most cases spectrum being unutilised/underutilised in the geographic area where the provider wishes to offer services. A dynamic licensing approach which would make use of available spectrum through providing a default answer of "yes" if the spectrum is not being used, and providing this assignment within minutes (if not seconds) would materially change the investment environment for such service providers. We would expect a significant increase in the number of areas where services can be provided by local mobile service providers and therefore a significant increase in the number of individuals benefitting from mobile connectivity from the introduction of DSA in LAL frequency bands.

In this use case we have focused on quantifying the benefits of providing local mobile coverage to poor coverage spots in rural areas. We note that there will also be poor coverage spots in urban areas, however it is likely to be more difficult for local mobile providers to obtain spectrum assignments in these areas due to the risk of interfering with the national mobile operators' use of the spectrum. Furthermore, if a particular spectrum assignment was withdrawn due to a mobile operator subsequently utilising the spectrum, it may not be possible to obtain an alternative spectrum assignment as it would be in rural areas where spectrum is less utilised. However we also note that interference modelling undertaken by QMUL as part of Work Package 2 of this sandbox (see Figure 4-1 below) has suggested that in some urban locations it may be possible for additional local mobile provider base stations to be deployed in some areas in addition to those deployed by the national mobile operator using the same frequencies.

Figure 4-1: Illustrative modelling of co-existence of national mobile operator base stations in London (left) and Bath (right) [Source: QMUL]



4.2 Methodology for quantification of benefits and costs

Our overall approach is to assess the benefits arising from the increased number of individuals who will have mobile coverage/a higher quality of mobile coverage, as a result of local mobile providers benefiting from the introduction of DSA in LAL spectrum bands. From this we deduct the costs associated with providing this connectivity resulting in an overall estimation of the net benefit, as shown in Figure 4-2 below.

Figure 4-2: High-level methodology for quantification of benefits and costs for local mobile coverage

(Number of additional connected users) × (Benefit per user) – (Cost of connecting users)

Whilst our quantitative assessment focuses on individuals and the locations of individuals, in reality the mobile connectivity will be of benefit to both individuals in each location as well as a range of devices (e.g. Internet of Things sensors) at/in the surrounding areas of the location. References to users or individuals in this analysis are therefore a proxy for providing connectivity to both individuals (or, more specifically, devices directly used by people) as well as standalone devices e.g. environmental sensors.

Our approach is summarised in Figure 4-3 below. This involved estimating the:

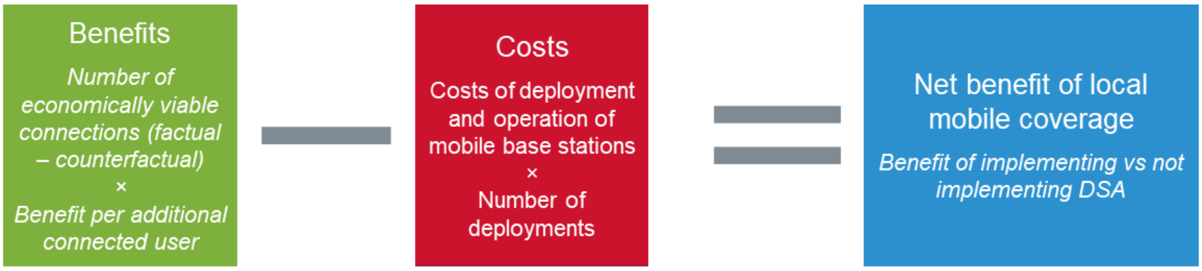
- **Number of economically viable connections:** We calculated the economically viable market (number of connected users) that can be served by granting local mobile providers access to local access spectrum using a dynamic access mechanism ("factual" scenario). We compared this against the number of connected users in the event that the current LSA licensing regime continues (counterfactual scenario) to estimate the incremental number of connected users.

- **Benefit per additional connected user:** We estimated the productivity and social welfare benefits from connecting each additional connected user, drawing upon third party research on such benefits. Additionally, we note that a proportion of the costs associated with the installation of new mobile base station sites is also likely to benefit the local economy and so we have also estimated this benefit.

- **Costs of deployment and operation of mobile base stations:** We estimated the costs associated with the deploying and operating new mobile base stations that are required to provide mobile services to the new connected users.

The overall net benefit of this use case is calculated from subtracting the costs of deploying and operating the mobile base stations from the estimate of benefits.

Figure 4-3: Methodology for calculating net benefit for local mobile coverage



4.2.1 Number of economically viable connections

We have estimated the number of economically viable connections in four key steps:

- Step 1: Estimate the number of users who are not connected or have poor connections ("maximum addressable market").

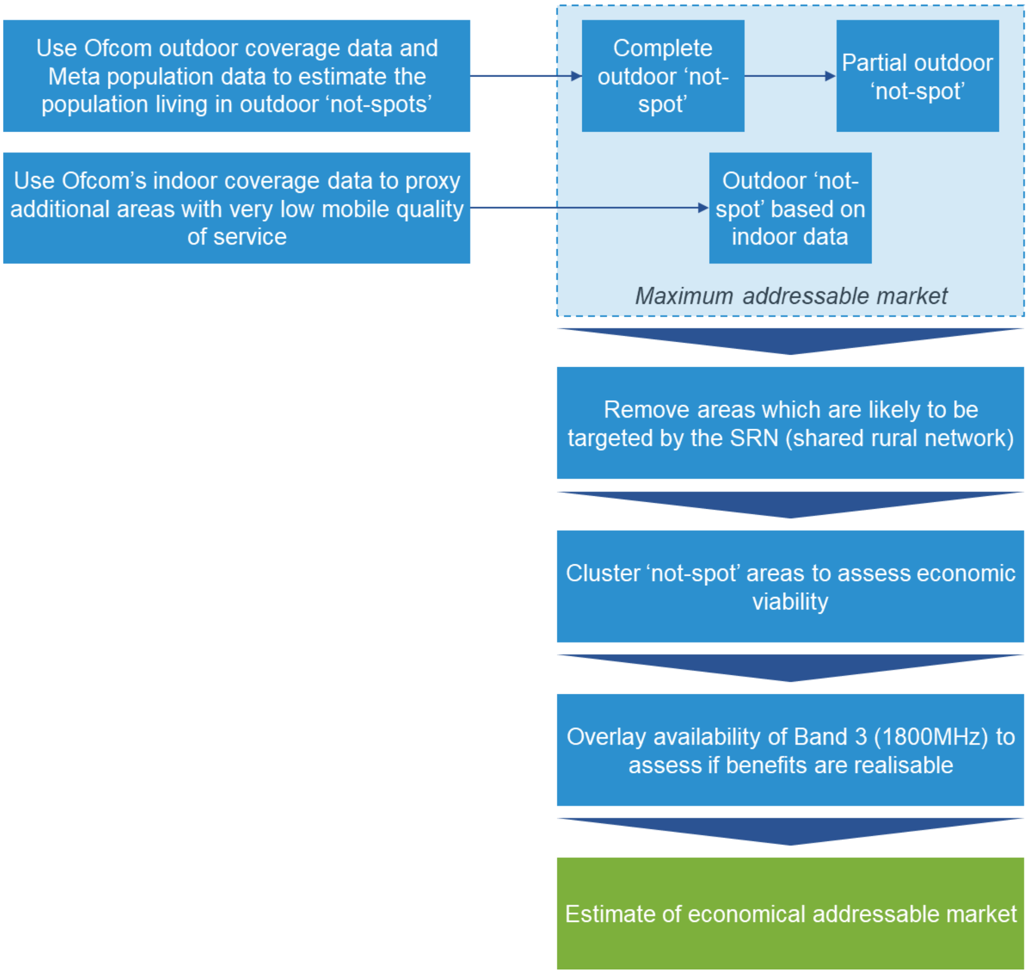
- Step 2: Subtract those users that are likely to be connected as a result of the UK Government's Shared Rural Network (SRN) programme

- Step 3: Identify those users are sufficiently close (clustered) together such that they would be within reach of a new base station and that there are enough users within reach to make service provision economically viable.
- Step 4: Check that sufficient spectrum is available for local access licences in each area. Deduct any users that are outside areas where spectrum is available.

Steps 1 to 4 of this approach are summarised in Figure 4-4 below.

Finally, in Step 5, we then apply a take-up rate to reflect the time taken to roll-out service by the local mobile providers and the time taken for users in the newly covered areas to benefit from service.

Figure 4-4: Overview of methodology for estimating the number of economically viable connections for local mobile providers



In this section, we detail these steps for calculating the additional demand from the new licensing regime in more detail.

Step1: Estimation of maximum addressable market

We identify the number of individuals in outdoor 'notspots', partial outdoor 'notspots' and indoor 'notspots' using data published by Ofcom and Meta.

Ofcom provides detailed coverage maps for each national operator (EE, Three, O2, Vodafone)[25]. These maps allow users to either input an address to check coverage or explore a visual representation of the UK divided into 100×100m grid squares. Each square is assigned a coverage rating—likely, limited, or none. Ofcom provides data for two categories of coverage: outdoor and indoor.

We supplemented the data from Ofcom with high-resolution population density data from Meta[26]. Meta's dataset combines satellite imagery with census data, offering a detailed spatial distribution of population across the UK. This synthesis enabled us to determine the number of people residing in areas categorised by Ofcom as having likely, limited, or no coverage for each operator. Furthermore, it allowed us to quantify the proportion of the UK population with no coverage or no likely coverage from any of the national operators (complete 'not-spots'), and the proportion with coverage from some but not all operators (partial 'not-spots').

We summarise the proportion of the UK population in areas of no outdoor coverage, limited outdoor coverage and likely outdoor coverage in Figure 4-5 below.

Figure 4-5: National mobile operators' outdoor coverage – % of UK population [Source: Aetha analysis using Ofcom coverage checker and Meta population data]

Operator / Metric	No coverage	Limited coverage	Likely coverage
EE	0.09%	0.28%	99.64%
O2	0.12%	0.49%	99.40%
Three	0.11%	0.86%	99.02%
Vodafone	0.11%	0.51%	99.38%
Complete 'not-spot'	0.05%	0.11%	
Partial 'not-spot'	0.15%	1.67%	

We also present a map showing this UK outdoor coverage data in Figure 4-6 below.

[25] Ofcom, 'Mobile and broadband checker', accessed 30 November 2024, https://checker.ofcom.org.uk/en-gb/mobile-coverage

[26] See Meta, 'High Resolution Population Density Maps', accessed at https://dataforgood.facebook.com/dfg/tools/high-resolution-population-density-maps#accessdata

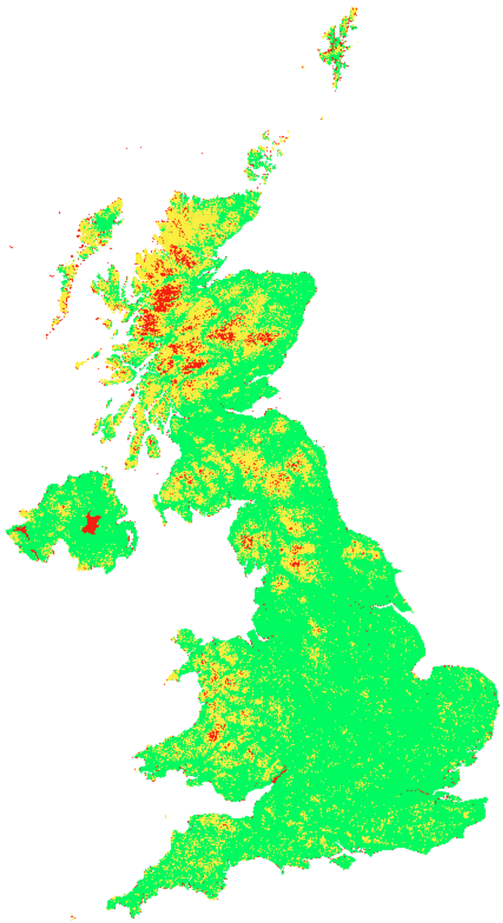


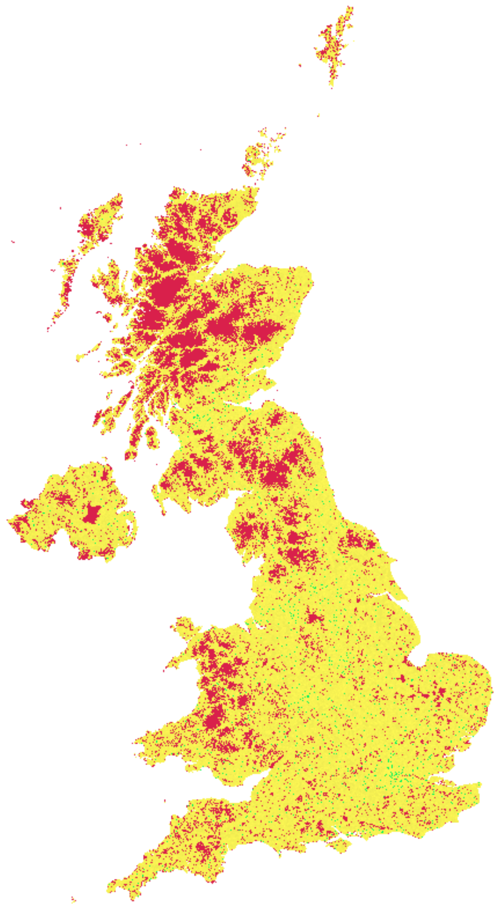
Figure 4-6: National mobile operators' outdoor coverage (Green = likely coverage from all operators, Red = no coverage from any operator, Yellow = in-between) [Source: Aetha analysis using Ofcom coverage checker data]

From measurements undertaken as part of Work Package 1 of this spectrum sandbox, we believe that this coverage may overstate true coverage in terms of being able to us data services reliably. As a consequence, we undertook a similar analysis, but making use of indoor coverage data provided by Ofcom. Our findings are summarised in Figure 4-7 below. A mapping of the analysis is shown in Figure 4-8 below.

Figure 4-7: National mobile operators' indoor coverage - % of UK population [Source: Aetha analysis using Ofcom coverage checker and Meta population data]

Operator / Metric	No coverage	Limited coverage	Likely coverage
EE	8.33%	61.70%	29.96%
O2	7.06%	64.70%	28.24%
Three	10.22%	62.35%	27.42%
Vodafone	8.80%	63.26%	27.94%
Complete 'not-spot'	1.07%	41.02%	
Partial 'not-spot'	20.84%	54.77%	

Figure 4-8: National mobile operators' indoor coverage (Green = likely coverage from all operators, Red = no coverage from any operator, Yellow = in-between) [Source: Aetha analysis using Ofcom coverage checker data]



As expected, indoor coverage by the national mobile operators significantly lags behind outdoor coverage. Notably, 1.07% of the UK population lives in areas without any indoor coverage from any of the four national operators, while 20.84% of the population experiences only limited indoor coverage.

Informed by this analysis, as well as the results from the measurements taken under Work Package 1, we categorised the potential addressable market for local mobile operators into three segments, to reflect varying levels of potential benefit per user from connectivity improvements. These segments together define the maximum addressable market for local mobile providers:

- Complete outdoors 'not-spot' as per the Ofcom data – areas with no outdoor coverage or only very limited coverage provided by any of the national mobile operators (expected to deliver largest benefit per user from improved connectivity) – 0.11% of UK's population.
- Partial outdoor 'not-spot' – areas with outdoor coverage provided by some but not all national operators (likely to yield smaller benefit per user from improved connectivity) – 1.67% of UK's population.
- Outdoor 'not-spots' based on Ofcom indoor data – areas with no indoor coverage provided by any of the national mobile operators, used as a proxy for outdoor areas with no or very low quality of service (expected to deliver significant benefit from improved connectivity, based on data from WP1 measurements phase) – 1.07% of UK's population.

Figure 4-9 below summarises the above three segments:

Figure 4-9: Maximum addressable market for local mobile providers

Segment	Proportion of population	Maximum addressable market
Outdoor ‘not-spots'	0.11%	69 092
Partial outdoor ‘not-spots’	1.67%	1 075 066
Indoor ‘not-spots’	1.07%	691 263

Step 2: Subtract users that will be covered by the Shared Rural Network programme

The Shared Rural Network (SRN) is a collaborative initiative between the UK government and the four national mobile network operators. The program aims to address mobile coverage gaps in rural and remote areas, enhancing geographic 4G coverage to 95% of the UK by the end of 2025[27]. It focuses on eliminating both complete outdoor ‘not-spots’ and partial outdoor ‘not-spots’. This is being achieved through a combination of network sharing and new infrastructure deployments in areas that currently lack adequate connectivity.

The SRN is expected to substantially reduce coverage gaps and we expect the SRN to have a significant effect on the size of the outdoor ‘not-spots’ (both complete and partial ‘not-spots’). Consequently, our base case assumes that these outdoor ‘not-spots’ will be effectively addressed through the SRN in the near future.

For the purposes of our modelling, we assume that the SRN will cover individuals in the outdoor ‘notspots’ and in the partial outdoor ‘notspots’ and therefore the main addressable market for local mobile service providers is those individuals that Ofcom’s data suggest fall within indoor ‘notspots’ (but do have outdoor coverage) but the measurements from Work Package 1 of this project suggest might not have a high-enough quality of service for reliable data transmission. This addressable market is summarised in Figure 4-10 below.

Figure 4-10: Addressable market for local mobile providers post SRN

Segment	Potential addressable market	Maximum addressable market post-SRN
Outdoor ‘notspots'	69 092	0
Partial outdoor ‘notspots’	1 075 066	0
Indoor ‘notspots’	691 263	691 263

We note that recent press reports have suggested that government funding towards this project may not reach the forecasted levels for the current coverage ambitions.[28] However, to date, the SRN has met its ambitions and plans are in place until towards the end of 2027. Therefore we assume that the SRN will meet its coverage ambitions for existing outdoor and partial outdoor ‘not-spots’, and that our forecast represents a minimum addressable market – should investment in the SRN be stifled in the future and some of the outdoor and partial outdoor ‘not-spots’ remain unserved by national mobile

[27] Shared Rural Network website, accessed 2 December 2024, https://srn.org.uk/about/

[28] See, for example, The Telegraph, Labour cuts back £1bn project to tackle rural mobile ‘not-spots’, 1 Feb 2025.

operators, the addressable market for local mobile providers could increase by a factor of 2.5 (to include the 69 000 individuals in outdoor 'not-spots' and 1.1 million individuals in partial outdoor 'not-spots').

Additionally, the advent of 'direct to device' mobile services could mean that some of these users receive mobile coverage through satellite connectivity. However, we expect that these services will take some time to develop and in the short to medium-term will provide low rates of data connectivity (due to the distances travelled by the signals) and will therefore not be an adequate substitute for terrestrial mobile coverage.

Step 3: Identify users sufficiently close (clustered) together

We then considered the distribution of the users in the addressable market (post SRN) and whether they live sufficiently close to each other for local mobile service providers to provide service to profitably. Users need to lie within a certain distance of a radio base station in order to be covered by it.

To inform our analysis, we engaged Telet to provide insights into its market strategy and deployment costs. Telet's most widely deployed configuration features a 4×4 MIMO n77 antenna capable of delivering a capacity of 1Gbps within a coverage radius of, at a minimum, 1km (the actual coverage radius can extend beyond this, depending on geography, types of buildings, the antenna deployed on the base station site and the antenna in the customer's devices). Telet targets around 50 mobile users per deployment. Assuming that local mobile providers would follow a neutral host model where they could serve customers of all national mobile operators, and assuming ~90% of the population covered has or will acquire a mobile subscription, local mobile providers such as Telet would therefore target clusters with a population of around 60.

To assess the number of the users in the addressable market (post SRN) that meet the above criteria, we created clusters of population living in 'not-spots', ensuring that the distance between any two points within cluster is at most 2km (twice the cell radius). Another reason for excluding the population living in partial 'not-spots' in the previous stage of analysis is that we expect the take-up rates to be significantly smaller in these areas.

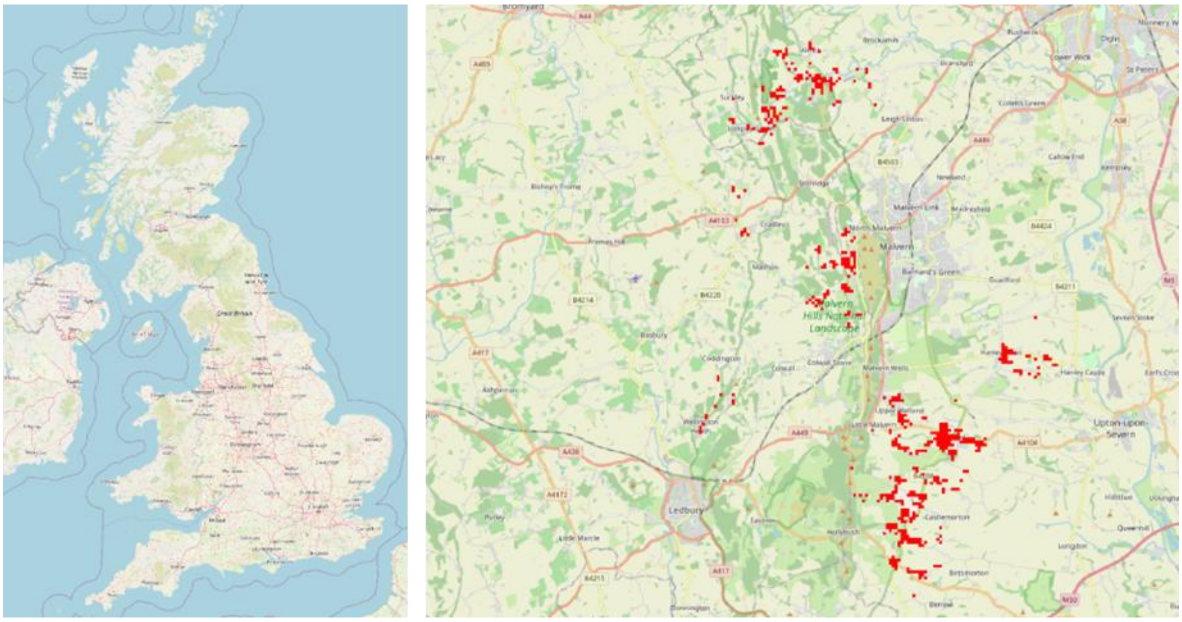
We present the results from our analysis in Figure 4-11 below.

Figure 4-11: Split of addressable market (post SRN) by cluster type

Cluster definition	Addressable market (post SRN)
Living in clusters with population: <60	279 000
Living in clusters with population: ≥60	412 000
Total	**691 000**

Figure 4-12 below shows a map of the defined clusters across the UK but these are difficult to see due to the granularity of the data. We therefore also show a zoomed in version focussed on the area surrounding Malvern.

Figure 4-12: Map of clusters in the UK and a sample of clusters near Malvern



Around 60% of the addressable market (post SRN) lives in communities that should be large enough to be covered profitably by the local mobile providers. This amounts to just over 400 000 individuals.

Step 4: Check for sufficient spectrum availability

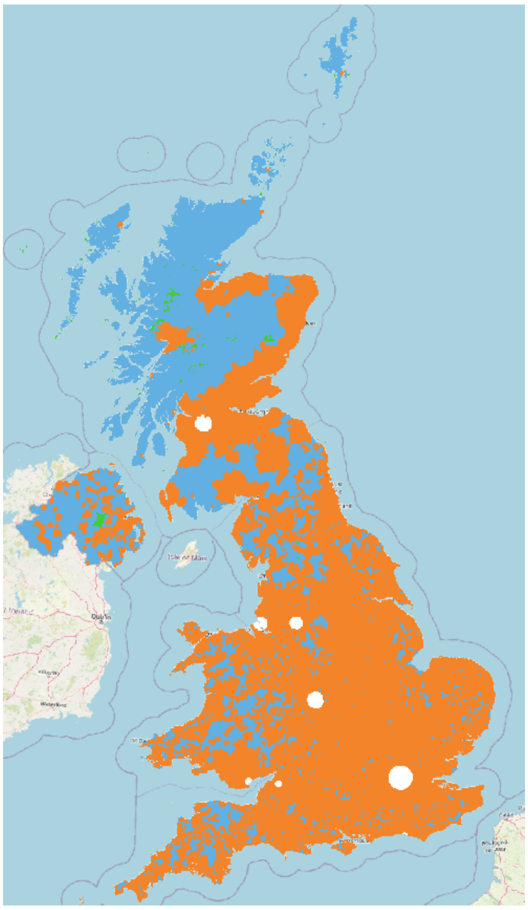
We assessed whether sufficient spectrum is available in the areas identified as being addressable by local mobile operators. To undertake this, we used data from Work Package 2 of the project, where QMUL and Federated Wireless used a model informed by ray-tracing analysis, as well as the measurements from Work Package 1, to create a nationwide picture of spectrum availability in Band 3 (1800MHz band). While this analysis does not include all the national mobile operators'-spectrum bands, we believe it is a good proxy, as it is a band that is widely deployed by some operators, such as EE, and only deployed in areas that required additional capacity by other operators, such as Vodafone and VMO2.

We present the map of spectrum availability[29] in Figure 4-13 below. Some Band 3 spectrum is available across most of the UK, with some exceptions for some large cities (Glasgow, Manchester, Liverpool, Birmingham, London, Cardiff, and Bristol).

Please note that this analysis does not take account of any additional 1800MHz spectrum that may become available as a consequence of the merger of Vodafone and Three. This could increase the spectrum availability beyond that shown below and result in higher economic benefits than we have modelled.

[29] This consider locations where the signal strength from the national mobile operator in the frequency channel should be less than -20dBm.

Figure 4-13: Nationwide Band 3 spectrum availability (white = no spectrum available, orange = up to 2×10MHz available, blue = 2×25MHz available, green = >2×50MHz available) [Source: Aetha analysis based on data provided by Federated Wireless and QMUL]



A summary of spectrum availability mapped against the addressable market for local mobile operators is shown in Figure 4-14 below.

Figure 4-14: Split of addressable market (post SRN, post clustering) by Band 3 spectrum availability

Spectrum available	Addressable market (post SRN, post clustering)
No spectrum is available	9 000
Up to 2×10MHz of spectrum is available	324 000
More than 2×10MHz of spectrum is available	79 000
Total	**412 000**

In most populated 'not-spot' areas, up to 2×10MHz of 1800MHz spectrum is available, whereas in a minority of locations more than 2×10MHz is available, and in very few locations no spectrum is available. We exclude areas where no spectrum is available from the overall addressable market for the local mobile providers. Therefore the final total estimate for the economically addressable market is 403 000 individuals.

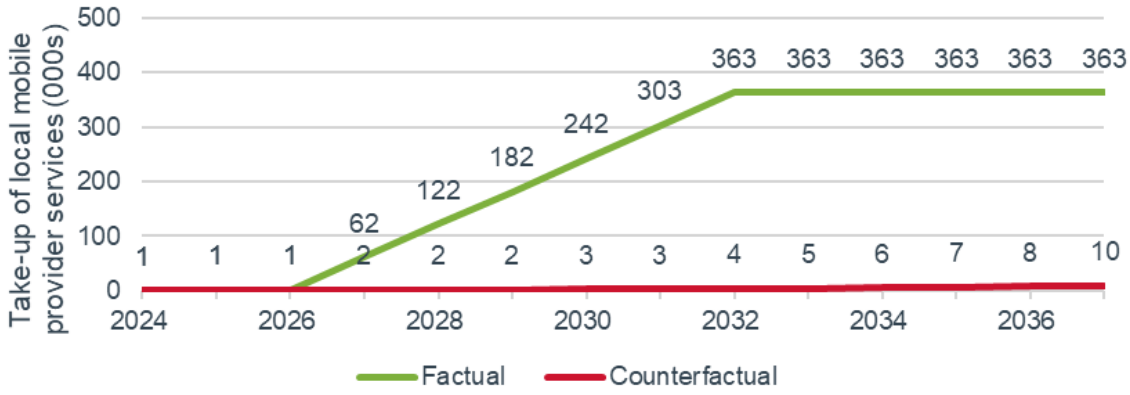
Step 5: Take-up rates

Our estimate of the economical addressable market in the base case factual scenario for local mobile providers is ~403 000. We assume implementation of DSA will occur during 2027, and that by the end of 2032, 90% of the economical addressable market in the expanded coverage areas will have taken-up the services offered by local mobile providers.

As a counterfactual (the case where dynamic access to local access licensed spectrum is not available), we assume that local access licence deployments grow at an annual rate of 20% (in line with broad historic trends)[30].

Figure 4-15 below shows the forecasted number of individuals taking up services from local mobile providers under both our main scenario and the counterfactual scenario.

Figure 4-15: Take-up of local mobile provider services in the main scenario and counterfactual (no DSA) scenario



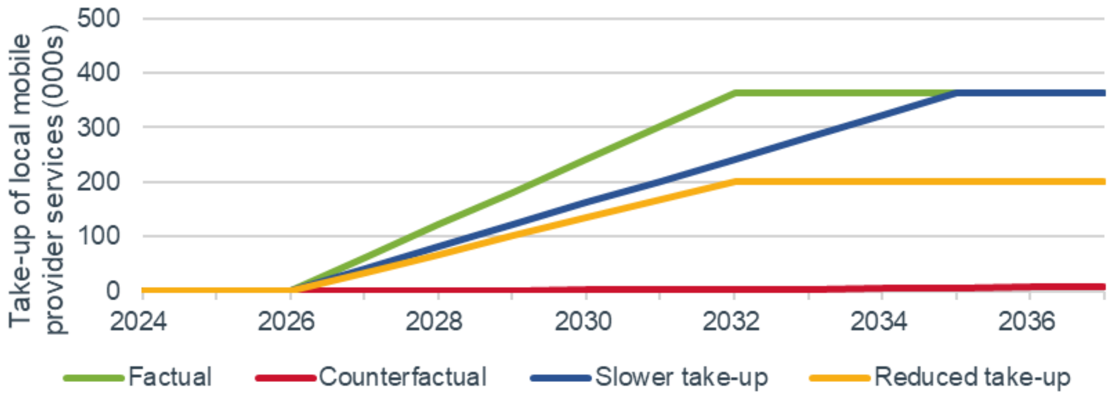
Given the uncertainty of this take-up forecast, we have also developed alternative take-up scenarios, assuming there were:

- Slower rate of take-up: instead of assuming all addressable market will have taken up local mobile services by 2032, we assume it takes an additional 3 years (i.e. by the end of 2035). This means that the full benefits will not be realised as early – however, it also reduces the cost requirement for deployments during those years (as less deployments will be necessary).
- Reduced rate of take-up: we assume a take-up rate of 50% (~202 000 individuals) rather than 90% (~363 000 individuals) of the addressable market.

The take-up of local mobile provider services for all four scenarios (the base case Factual scenario, Counterfactual, slower rate of take-up and Reduced rate of take-up is shown in Figure 4-16 below.

[30] As of January 2025, 27 Local Access Licences are in operation. Of these, 15 are issued to local mobile providers – 9 licences for Freshwave, and 6 licences for Telet.

Figure 4-16: Take-up of local mobile provider services in the Factual, Counterfactual, and alternate scenarios



4.2.2 Benefit per additional connected user

We undertook a review of existing studies assessing the economic benefits of mobile connectivity, particularly for those users living in coverage 'notspots'. From this we identified two key studies of greatest relevance – namely:

- Analysis of community benefits of mobile investment (FarrPoint, 2024)
- Estimating the value of mobile telephony in mobile network 'not-spots' (RAND Europe, 2014).

A detailed summary and review of these reports can be found in Annex A.1 of this report.

We used the results of these third party studies to ensure our economic benefit estimates are anchored in the reality observed in studies with a more detailed scope of work (such as surveying people living in 'not-spots'):

From these studies, we identified three key sources of benefit that are of most relevance to the increased mobile connectivity arising from local mobile service providers benefiting from DSA:

- **Productivity**. Improved mobile connectivity enhances productivity by enabling more efficient business operations, greater workforce flexibility, and increased access to digital tools. In rural areas, where businesses may be constrained by limited connectivity, this uplift can have significant economic effects. We estimated economic impact of improved mobile connectivity by estimating the Gross Value Added (GVA) uplift attributable to investment in infrastructure.
  - Our analysis assumes a 0.5% annual growth in GVA for the population benefiting from improved mobile coverage (this is the uplift assumed in the FarrPoint report). GVA is calculated using regional data from the Office for National Statistics[31], and future growth projections in GVA from a 2024 report from EY[32].
  - We assume that the GVA uplift persists in the first two years following the addition of mobile connectivity in an area, but it then declines at a rate of 12.8% – as data on persistence of

[31] ONS Dataset: 'Revisions triangles: regional gross value added (balanced) in current basic prices', accessed at https://www.ons.gov.uk/economy/grossvalueaddedgva/datasets/revisionstrianglesregionalgrossvalueaddedbalancedincurrentbasicprices

[32] EY ITEM Club, 'UK Regional Economic Forecast', February 2024, accessed at https://www.ey.com/content/dam/ey-unified-site/ey-com/en-uk/newsroom/2024/03/ey-uk-regional-economic-forecast-03-2024.pdf

benefits from improved mobile connectivity was not available, this assumption is informed by the historical results of the UK's Superfast Broadband Programme[33].

- **Social welfare**. We were not able to specifically identify a quantitative analysis of the impact of social wellbeing from improved mobile coverage, but there is agreement that such a benefit does exist. For the purposes of our estimations, we drew upon the impact of the UK's Superfast Broadband Programme. The 2018 interim report[34] linked wellbeing impacts with national survey data, concluding that living in a postcode within a superfast broadband intervention was associated with a wellbeing uplift of GBP222.25 per year per premises.

  – Based on this assessment and adjusting for the average size of a household in the UK (2.36 residents per household[35]), we assumed that, if a person lives in an area with poor mobile coverage and also does not have access to superfast broadband, the wellbeing benefit from getting access to high quality mobile connectivity for that person is GBP94.17 per year – the superfast broadband wellbeing uplift per household (GBP 222.25) divided by the average household size (2.36). In those areas where the individual would have access to high-speed broadband, we assume that the wellbeing uplift from improved mobile connectivity would amount to GBP47.09 per year (50% of the benefit for a person without access to superfast broadband.

  – We note that there is a high level of uncertainty regarding the magnitude of the social welfare benefits of high-speed connectivity. For example, a subjective wellbeing data analysis from 2020 for the evaluation of the UK's Superfast Broadband Programme found mixed evidence regarding the impact of superfast broadband on the wellbeing of the people living in the upgraded areas. However, at the same time, it is possible that the benefits of connectivity may have increased since 2020, for example due to the impact of COVID-19 and the general increased reliance on connectivity.

- **Additional local economy benefits**. The construction and operation of the new radio sites should overall provide some additional benefits to employment growth and the local economy. This activity often has a multiplier effect, as wages earned by workers and payments to suppliers circulate back into the local economy – however, to be prudent, we have only considered the initial impact (i.e. no multiplier effect).

  – For the purposes of our analysis, we assume that 15% of the base station deployment and ongoing operational costs will generate local and national economic benefits. We note that this proportion is lower than the assumption of 25%-50% used in FarrPoint's analysis report, since although we assume that local mobile providers are more inclined to source equipment and services locally compared to the national mobile operators, which often rely on centralised procurement and external contractors, there would be a large proportion of cost items which are not locally sourced (e.g. radio equipment, power).

[33] Building Digital UK, 'Superfast Broadband Programme Evaluation: Key Benefits and Impacts, 2021', accessed at https://assets.publishing.service.gov.uk/media/601ad95fd3bf7f70b95eea44/DCMS_Superfast_Findings_Briefing_v1.pdf

[34] Building Digital UK, 'Superfast Broadband Programme Evaluation: Key Benefits and Impacts, 2021', accessed at https://assets.publishing.service.gov.uk/media/601ad95fd3bf7f70b95eea44/DCMS_Superfast_Findings_Briefing_v1.pdf

[35] Office for National Statistics, 'Families and Households in the UK, 2022', accessed at https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families/bulletins/familiesandhouseholds/2022

4.2.3 Costs of deployment and operation of mobile base station sites

In providing higher speed mobile services to individuals in areas of poor mobile coverage, the local mobile service providers will incur costs for the deployment and operation of new radio sites.

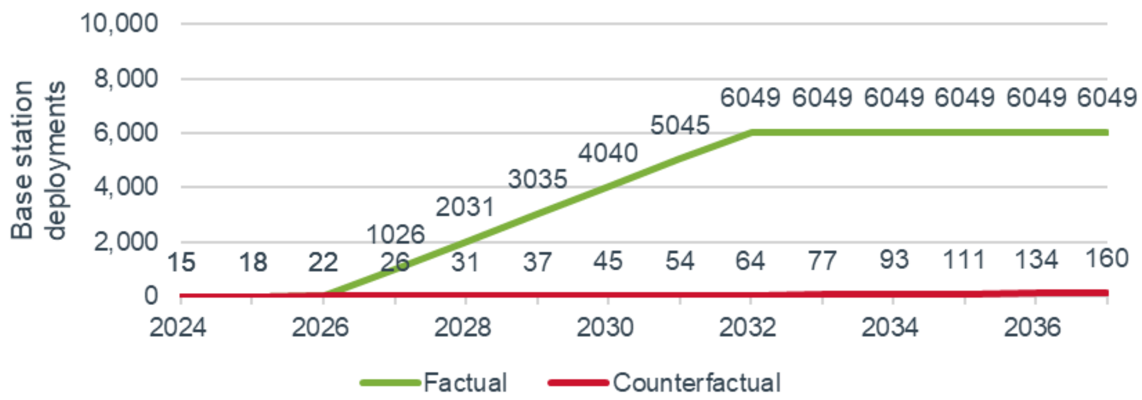
We understand from discussions with Telet that local mobile providers are able to deploy mobile coverage sites at a significantly lower cost than the national mobile operators in more rural areas. Figure 4-17 shows the cost assumptions we have used for the deployment of a site, based on discussions with Telet, who have indicated a typical cost per premise (UPRN) would be around GBP1000.

Figure 4-17: Cost of installation, operation, and maintenance of mobile coverage site by local service provider

Cost item	Cost as of 2025 (GBP)	Annual price trend
Initial deployment costs		
Radio equipment and ancillaries	10 000	0%
Civils	4000	Inflation
Backhaul	5000	0%
Other	4000	Inflation
Operation and maintenance		
Power	1000	Inflation
Other operations and maintenance	2000	Inflation
Lease	3000	Inflation

Each base station is assumed to serve ~60 potential users, as detailed above. Based on the take-up forecasts presented above, we forecast the number of base stations required in the Base case Factual scenario and the Counterfactual scenario in Figure 4-18 below.

Figure 4-18: Number of base station deployments required



We note that the 5G base stations will need to be connected to a core network (their own or potentially make use of a third-party cloud-based core network). We have not modelled the cost of the core network since we assume that local service providers will already have access to the core network (e.g. as part of their wider business operations, which are not dependent on the introduction of DSA), and any incremental costs will be minimal.

4.3 Results

The overall benefits gained from the additional access to spectrum for local mobile providers via a dynamic sharing solution are presented in Figure 4-19 below.

Figure 4-19: Summary of benefits and costs from extending local mobile coverage via dynamic sharing of spectrum (2025-2036)

Source of value/cost	Total value 2025-2036 (GBP million)	Net present value 2025-2036 (GBP million)
Productivity impact	272.0	207.2
Social welfare benefits	189.6	141.9
Costs	(434.8)	(334.2)
Additional benefits to local economy	68.1	52.6
Total	**95.0**	**67.4**

These results show that there is a net benefit of around GBP65 million in net present value terms over the period 2025-2036. The net present value is as of 2024/2025.

As discussed above, we also undertook several sensitivities assuming lower levels of take-up of local mobile provider services in the underserved areas:

- Slower take-up rate: **90%** of the economically addressable market takes up this service by **2035**
- Reduced take-up rate: **50%** of the economically addressable market takes up this service by **2032**.

The outcome of this analysis can be seen in Figure 4-20 below and the base case is highlighted. It can be seen that the overall net benefit (net present value 2025-2036) lies within the range of between GBP35 to GBP70 million.

Figure 4-20: Summary of benefits and costs from extending local mobile coverage (2025-2036) - under different take-up assumptions

Take-up rate	Total value 2025-2036 (GBP million)	Net present value 2025-2036 (GBP million)
Base case	**110.8**	**67.4**
Slower take-up rate	65.0	45.5
Reduced take-up rate	52.4	37.2

We note however that we have assumed that a large number of individuals that today could be targeted by local mobile service providers will instead obtain high-speed mobile coverage from the UK Government's Shared Rural Network (SRN), and individuals living in these areas are excluded from this assessment. However, should the SRN initiative not fulfil its ambition of fully eliminating complete and partial outdoor 'not-spots' across all these areas as planned, the economic benefits from local mobile coverage could be up to ~2.5× our level of estimated benefits.

There are also several qualitative advantages of local mobile providers having dynamic access to spectrum. The national mobile operators may be able to benefit from the provision of services by local mobile providers acting as neutral hosts, which may in turn increase the levels of competition in the local area due to the increase in choice of service providers. Furthermore, by making efficient use of shared infrastructure and efficiently utilising the spectrum, there may be further environmental benefits (including lower power consumption).

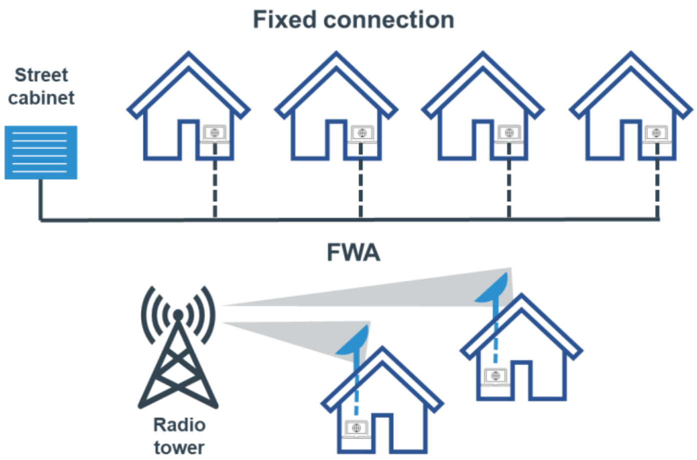
5. Use case 2: Extending the reach of Fixed Wireless Access (FWA)

5.1 Introduction

In summary, access to spectrum used for local access licences would allow providers of fixed access services to cover a greater area from a base station site (radio tower) than through using other higher frequency bands, thereby covering a greater number of premises and improving the economics of service provision in very rural areas. In such rural areas, the main alternative means of having a super-fast broadband connection is likely to be through a satellite service and so such premises will benefit from higher-speeds and lower latency connections that would otherwise be the case.

Fixed Wireless Access (FWA) is a technology that provides high-speed internet connectivity by delivering broadband services wirelessly to fixed locations such as homes and businesses. As shown in Figure 5-1, unlike traditional wired connections that rely on physical infrastructure (such as fibre), FWA uses radio signals transmitted from a base station to a customer's premise, where a receiver (antenna or router) is installed. For an FWA network, a fibre or wireless backhaul connects a radio tower, this tower then uses radio frequencies to connect the houses in its service area. This contrasts with a fixed connection, where a fixed line will connect an exchange to a street cabinet that will then link the houses in its service area.

Figure 5-1: Schematics of fixed line and FWA connections



FWA can use a range of wireless technologies to provide connectivity – however most recently FWA connections have been provided using mobile technologies such as 4G or 5G to benefit from the economies of scale of the mobile equipment ecosystem.

For this reason, several of the national mobile operators offer FWA services using spare capacity in their mobile network. For example, national operators can utilise their 3.5GHz spectrum for FWA. This spectrum can have a large amount of unutilised capacity, especially in rural areas. Services are also offered in urban areas, in competition with fixed wireline solutions.

Additional there are several smaller providers of FWA services to customers (including Telet). Often these make use of higher frequency bands e.g. 5.8GHz band, mmWave spectrum (e.g. 24/26GHz[36],

[36] We note interest in use of mmWave spectrum for FWA has been greatest in the USA (28GHz band) – adoption in Europe, including the UK, has been very limited.

60GHz[37]) as well as the Shared Access Licence frequency bands including the 3.8-4.2GHz range (Band n77).

Large channel bandwidths are required to provide the highest speeds to users (e.g. 100MHz or more of spectrum is needed to provide speeds at/approaching Gigabit broadband).

By having dynamic access to local access licence and shared access licence spectrum, local service providers would benefit from:

- **Expanded FWA coverage:** Extending their services to a larger number of premises, particularly in sparsely populated or remote areas, through the use of lower frequency bands which cover greater areas.
- **Reduced costs of deploying FWA:** Lower-frequency bands require less infrastructure to cover the same area, making deployments more cost-effective.
- **Accelerated FWA deployment:** Streamlined licensing procedures (access to spectrum within minutes if not seconds) would enable faster rollouts of FWA services, reducing delays caused by the existing application processes.

Ofcom currently estimates that there are approximately 100 000 properties across the UK that are "Very hard to reach" and would require government intervention to provide them access to a superfast broadband connection[38]. DSA could help enable the provision of FWA superfast broadband services to some of these underserved premises, as an alternative to satellite connections which would be higher cost and have a poorer quality of service (e.g. higher latency).

5.2 Methodology for quantification of costs and benefits

Our overall approach is to assess the benefits arising from the increased number of premises that would benefit from a FWA connection instead of satellite as a result of the introduction of dynamic access to spectrum allocated for local access and shared access licences. From this we deduct the costs associated with providing this connectivity, resulting in an overall estimation of the net benefit.

Figure 5-2: High-level methodology for quantification of benefits and costs for extending FWA

(Number of additional premises served) × (Benefit per premise) – (Cost of connecting premises) adjusted for Double counting of costs/benefits from UC1

Our approach is summarised in Figure 5-3 below. This involved estimating the:

- **Number of additional premises served by FWA:** We first calculated the additional number of premises that could be served by FWA by granting FWA providers access to additional available spectrum through DSA. Some business premises may also benefit from receiving FWA services earlier than they would take-up satellite services and so we also estimate the number of these premises.
- **Benefit per FWA additional connected premise:** We estimated the main benefit to connected premises as arising from lower connectivity costs (compared to a satellite service). Additionally, some premises would also benefit from earlier connectivity to high-speed services and we

[37] Using licence-exempt spectrum in the UK.

[38] DSIT, 'Digital Connectivity: Consultation on Improving Broadband for Very Hard to Reach', October 2023.

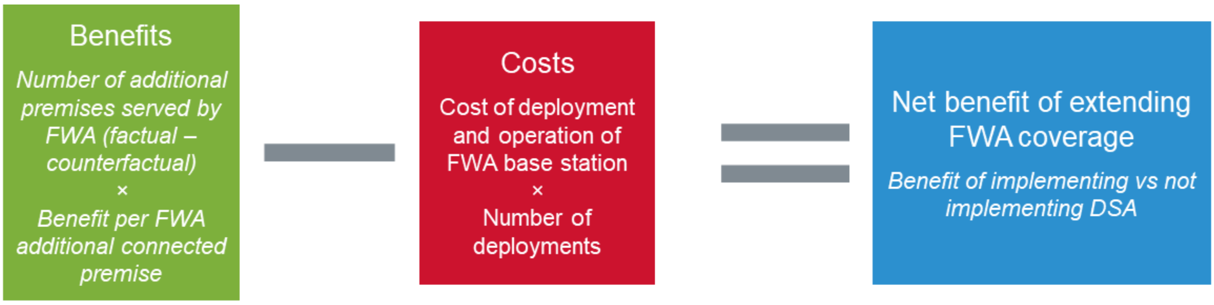
calculated the associated benefits of these including productivity and social welfare gains. Furthermore, a proportion of the costs associated with the installation of new base stations to provide the FWA services to customers is also likely to benefit the local economy and so we estimate this benefit.

- **Costs of deployment and operation of FWA base station:** We estimated the costs associated with the deployment an operation of new base station sites that are required to provide FWA services to the new connected users.

The overall net benefit of this use case is calculated from subtracting the costs of deploying and operating the FWA base stations from the estimate of benefits.

Additionally, we observed that several of the locations in which the FWA base station sites would be deployed would be the same areas in which additional local mobile service providers may deploy sites. This would result in a lower cost of overall deployment and also the benefits of providing high-speed connectivity may not be as high (i.e. there is a risk of double counting some of the benefits). We have therefore adjusted our calculations of estimated benefits to remove this double counting.

Figure 5-3: Methodology for calculating overall benefits for extending FWA



5.2.1 Number of additional premises served by FWA

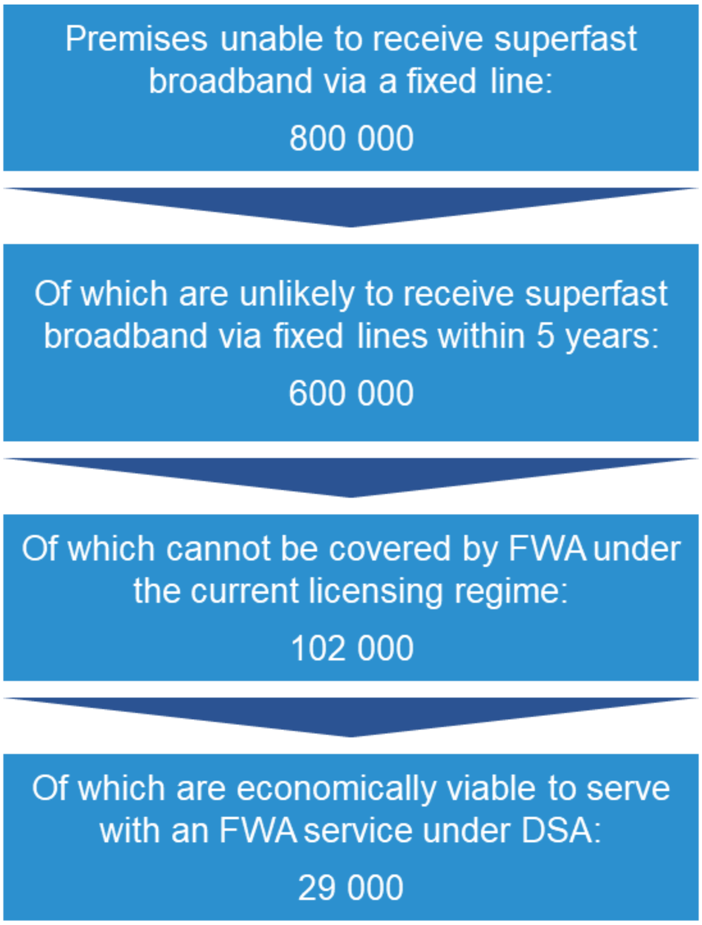
We have estimated the number of additional premises that could be served by FWA connections in four key steps:

- Step 1: Estimate the number of premises that are currently unable to receive superfast broadband services through a wireline service.
- Step 2: Subtract those premises that are likely to receive superfast broadband through a wireline service in the next 5 years (e.g. through the roll-out of fibre connectivity).
- Step 3: Subtract those premises that are likely to be offered FWA services under the existing licensing regime – including by both the national mobile operators and also smaller fixed wireless access service providers.
- Step 4: Identify those premises are sufficiently close (clustered) together such that they would be within reach of a new base station and that there are enough users within reach to make service provision economically viable.

Steps 1 to 4 of this approach are summarised in Figure 5-4 below.

Finally, in Step 5, we then apply a take-up rate to reflect the time taken to roll-out service by the FWA providers.

Figure 5-4: Overview of methodology for estimating the number of additional premises that could be served by FWA



In this section, we detail these steps for calculating the additional demand from the new licensing regime in more detail.

Step 1: Estimation of the number of premises that are currently unable to receive superfast broadband

When considering the demand for FWA services in rural areas, the first step was to consider the number of unique premises that do not currently have superfast broadband provision via a wireline service. We calculated this figure based on connectivity data published by Ofcom[39], which details the percentage of premises in each postcode lacking access to superfast broadband via a fixed line.

[39] Ofcom, Fixed coverage, accessed 4 December 2024, https://www.ofcom.org.uk/phones-and-broadband/coverage-and-speeds/connected-nations-2024/data-downloads-2024/

We combined this data with the number of premises in each postcode provided by nomis for England and Wales[40] and by NISRA for Northern Ireland[41]. Postcode locations were identified using the Code-point database provided by the Ordnance Survey.[42]

For Scotland and other UK postcodes lacking data on premises per postcode, we estimated the number of distinct premises using population data from Meta[26]. To estimate the number of premises from population data, we first defined the geographic extent of each postcode using Voronoi polygons. Voronoi polygons divide space into regions based on the proximity to specified points. With these postcode areas we were able to determine the population for each postcode within the UK. Using an average number of residents per household of 2.36 from ONS data[43], we were then able to estimate the number of premises for those postcodes for which we did not have official data.

Our calculations resulted in a mapped estimate of 785 000 premises in the UK without superfast broadband access via a fixed line. The latest estimates from Ofcom suggest that there are 750 000 residential premises without superfast broadband via a fixed line in the UK[44], aligning with this figure (even with the inclusion of non-residential properties).

Figure 5-5 presents a map showing the percentage of postcodes without access to superfast broadband via a wireline connection.

[40] For England and Wales: ONS, 'nomis: Official census and labour market statistics', accessed 10 December 2024, https://www.nomisweb.co.uk/sources/census_2021_pc

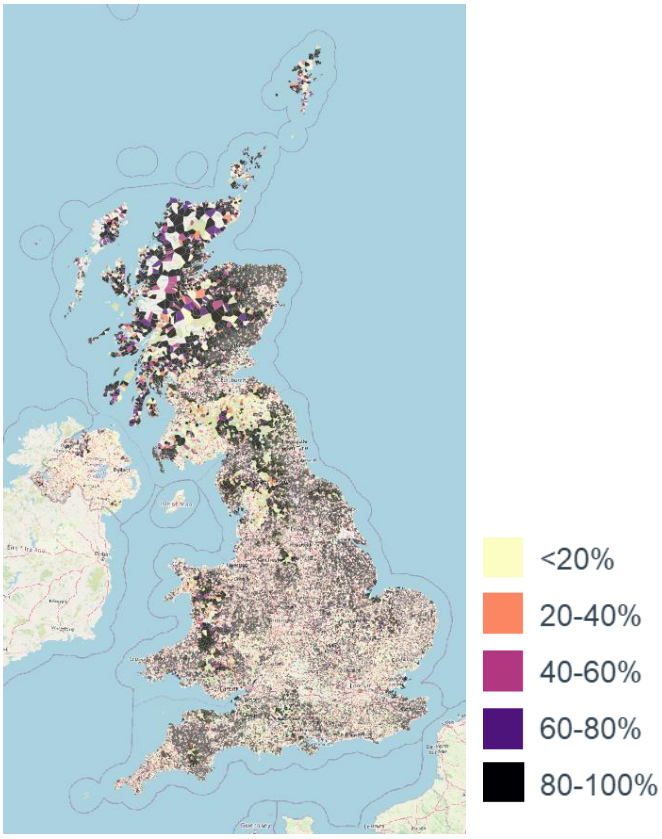
[41] For Northern Ireland: NISRA, 'Census 2021 person and household estimates for postcodes in Northern Ireland', accessed 10 December 2024, https://www.nisra.gov.uk/publications/census-2021-person-and-household-estimates-for-postcodes-in-northern-ireland

[42] Ordnance Survey, 'Code-Point', accessed 5 December 2024, https://www.ordnancesurvey.co.uk/products/code-point

[43] ONS, 'Families and households in the UK: 2022', 18 May 2023.

[44] Ofcom, 'Connected Nations UK Report 2024', 5 December 2024.

Figure 5-5: Percentage of households within each postcode without access to superfast broadband via a wireline connection



The number of postcodes corresponding to different proportions of households without superfast broadband access via a wireline connection in summarised in Figure 5-6 below.

Figure 5-6: Number of postcodes corresponding to different proportions of households without access to superfast broadband via a wireline connection

Percentage of households without superfast broadband via a fixed line	Number of postcodes
<20%	52 303
20-40%	22 639
40-60%	15 832
60-80%	11 258
80-100%	79 634

We found that ~12% of postcodes across the UK contain some premises that do not have access to superfast broadband via a fixed line. Within these postcodes, ~40% of premises lack this access.

Step 2: Elimination of premises that are likely to receive superfast wireline broadband coverage in the next five years

In the previous step we calculated that there are a significant number of premises across the UK that do not have access to superfast broadband via a fixed line. This number can be expected to decrease in the near future as there is currently an ongoing rollout of additional fixed-line capacity to connect new homes across the United Kingdom via Project Gigabit[45], a government programme with the aim to enable hard to reach communities to access fast, reliable, gigabit-capable broadband.

Phase 3 of Project Gigabit awarded 67 contracts which had connected 330 000 homes by the end of 2023, with 197 000 more homes planned to be connected by the end of the project.[46] This is in line with the rate of premises that have been upgraded to superfast broadband via a fixed line in recent years (an additional 100 000 existing residential premises having gained access to superfast broadband via fixed lines over the last two years).[47]

This suggests that we can expect around 200 000 premises to gain superfast broadband via a fixed line in the coming years, leaving an addressable market of around 600 000 premises that should not expect to receive superfast broadband via a fixed line in the near future.

Step 3: Elimination of premises that could receive FWA under the existing licensing regime

To calculate the number of premises that could incrementally benefit from access to FWA services as a result of the introduction of DSA, we adjusted for the number of premises that could receive FWA under the existing licensing regime.

We considered two types of provider of FWA services under the existing licensing regime – the national mobile operators and existing fixed wireless access providers.

To estimate the number of premises able to receive superfast broadband via FWA from a national mobile operator, we cross-checked the premises we earlier identified as being unable to receive superfast broadband from a wireline connection with forecast indoor coverage from the national mobile operators as shown in Figure 5-7 from Ofcom's coverage checker data,[25] on the assumption that good indoor coverage is a proxy for the signal strength required to receive a high-speed fixed wireless access service (e.g. using an externally mounted antenna).

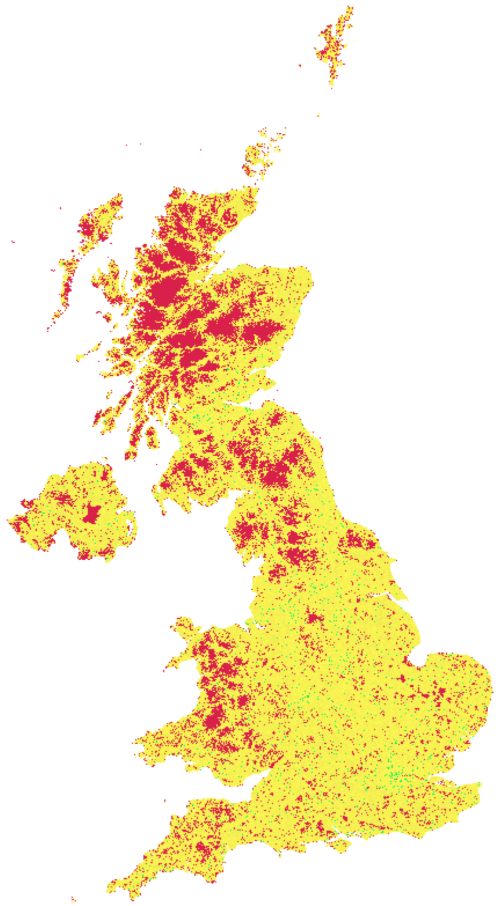
---

[45] See: UK Government, 'Project Gigabit', accessed at https://www.gov.uk/guidance/project-gigabit-uk-gigabit-programme

[46] Ipsos, 'Evaluation of the Superfast Broadband Programme', February 2023.

[47] Ofcom, Connected Nations UK Report 2024, 5 December 2024.

Figure 5-7:
Indoor coverage provided by national mobile operators (Green = likely coverage from all operators, Red = no coverage from any operator, Yellow = in between) [Source: Aetha analysis using Ofcom coverage checker data]

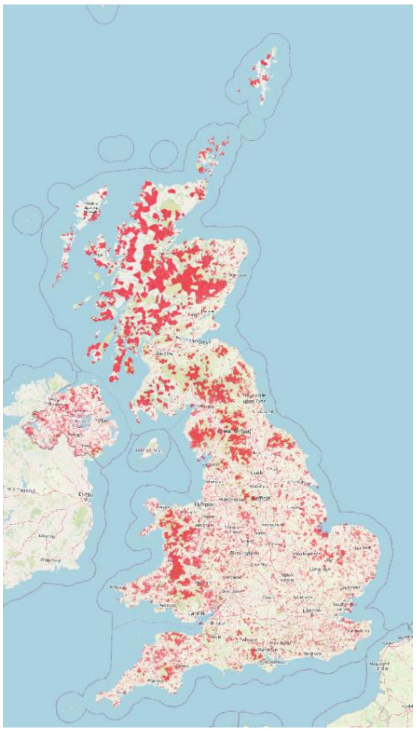


We have assumed a premise is likely to be able to receive superfast broadband speed through an FWA service if the postcode in which it is located is marked as receiving either limited coverage from at least two national mobile operators *or* likely coverage from a single national mobile operator.

It is unclear how willing the mobile operators will be to promote FWA in each of these areas, as they are likely to design their networks primarily for mobile use and may prefer to avoid increased network load from extensive FWA deployments, especially in hard to reach areas. However, for the purposes of this economic assessment and to avoid overstating the benefits of spectrum sharing for FWA, we have assumed that areas that have indoor mobile signal from a national mobile operator do not require additional access to superfast broadband as we assume at least one mobile operator will provide these services.

Based on this assumption, we estimated that there are 102 000 premises across the UK that will be unable to receive superfast broadband speeds via a wireline service or via FWA from a national mobile operator. This is in broad alignment with the estimate of 100 000 premises identified by Ofcom[38] as "Very hard to reach" which are unable to receive ultrafast broadband speeds either from a fixed line or FWA provided by a national mobile operator. A mapping of these postcodes is shown in Figure 5-8 below.

Figure 5-8: Postcodes without complete access to superfast broadband via wireline or FWA services provided by a national mobile operator



In relation to areas in which existing local FWA service providers may offer coverage, we note that the existing local mobile service providers are currently able to serve 7% of premises in the UK (~2 000 000) with a high-quality broadband service[47]. This figure has remained largely unchanged since 2021 suggesting that under the current spectrum regime such FWA providers are unlikely to greatly increase their provision of superfast broadband access.

Step 4: Identify premises sufficiently close (clustered) together

Some of these premises identified as potentially addressable by FWA service providers will be in very rural areas lacking the density of housing required to deploy FWA services profitably. The premises need to lie within a certain distance of a radio base station in order to be covered by it.

We considered the number of connected premises required per FWA site and the range of an FWA site:

- In relation to the number of connected premises required per FWA site, to inform our analysis, we drew upon Telet's experience of providing fixed broadband services. Telet estimates that it would require around 50 Unique Property Reference Numbers (UPRN) in an area to justify deployment of an FWA service.
- In relation to the distance covered by a FWA site, we assumed that, on average, deployment of FWA will allow services at 4km from the antenna. We note that in reality this number is heavily dependent on geographic factors; for example, Ofcom provides a case study of Quickline, reporting download speeds of over 300Mbps at a distance of 17km from the mast site using Band n77 spectrum[48]). As there is considerable uncertainty in this assumption, we have undertaken sensitivity analysis on this.

[48] Ofcom, Connected Nations UK Report 2023, 19 December 2023.

To calculate the number of premises that meet the criteria outline above, we grouped postcodes together up to the 'sector' level (e.g. EH2 4). If a group of postcodes remained within an 8km diameter (using the areas of the Voronoi polygons associated with each postcode) it was considered possible to serve this grouping using FWA services. We then calculated the number of premises within each postcode that do not have access to superfast broadband via either a wireline (currently and in the near future) or are within the potential coverage for FWA services from a national mobile operator in order to calculate the number of potentially viable properties within the group of postcodes.

We considered a group of postcodes viable if it contained at least 50 premises lacking superfast broadband via wireline. This yielded a total number of additional premises which could be served by FWA of 29 000. Figure 5-9 shows how this number would vary under alternative site coverage assumptions.

Figure 5-9: Additional premises that can be served by FWA under different coverage radius assumptions

FWA site coverage radius (km)	Additional premises that could be served by FWA
3	10 000
4	29 000
5	44 000

Step 5: Take-up rates

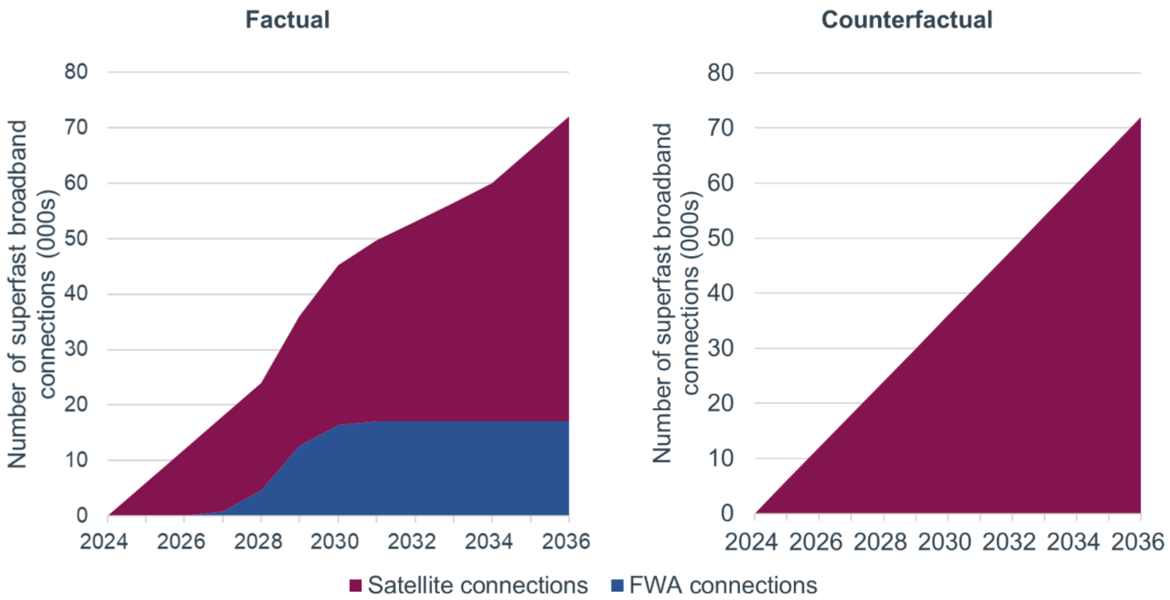
In our base case, where we have assumed a coverage radius of 4km, this has yielded a potential addressable market of 29 000. In relation to service-take-up, we have assumed a conservative take up rate of 60% (in line with WISPA estimates[49]). We have undertaken sensitivity analysis on this take-up assumption. The total number of additional FWA connections under these assumptions is ~17 000.

These premises would probably make use a satellite service if FWA was not available, as would the majority of other hard-to-reach premises.

We have therefore forecast the take-up of additional FWA connections and satellite by very hard to reach premises for both a scenario in which dynamic spectrum assignment of local access and shared access spectrum occurs (factual) and a scenario in which it does not (counterfactual). The take-up of additional FWA and satellite services in both scenarios is shown in Figure 5-10 below.

[49] UKWISPA suggest 60% is a conservative take-up rate for areas without fixed line connections, UKWISPA, THE ROLE OF WIRELESS NETWORKS IN ENHANCING DIGITAL CONNECTIVITY IN THE UK, 9 September 2024.

Figure 5-10: Number of new superfast broadband connections for 'Very hard to reach premises' in the factual and counterfactual scenarios



In developing these scenarios, we assumed that:

- Satellite take-up in hard to reach areas would occur at around 6000 premises per annum in the absence of a Fixed Wireless Access solution (broadly in line with estimated historic take-up rates in hard to reach areas).
- The additional FWA services in the factual scenario would be rolled-out between 2027 and 2030 and adoption would be flat thereafter.
- There would be some additional/accelerated take-up of FWA compared to satellite in view of its lower pricing and higher quality of service.

5.2.2 Benefit per FWA connected premise

To assess the benefit of the enhanced FWA connectivity, we considered two types of connected premises:

- Premises where FWA is a substitute for satellite connectivity. Here we considered the primary benefit of FWA is the lower pricing of services. We call this the 'competition' benefit of having FWA services. We note also that there would also be a higher quality of service (e.g. lower latency), but we have not identified a robust approach for quantifying this benefit.
- Premises which benefit from FWA instead of satellite connectivity or adopt FWA connectivity ahead of satellite connectivity. Here we consider the productivity and social welfare benefits arising from high-speed connectivity.

We estimated the competition benefit of FWA from comparing satellite connectivity service prices with likely FWA service providers. As of January 2025, the cost of a Starlink subscription for a residential property that offers unlimited usage and superfast broadband speeds is GBP75 per month[50]. For a comparable level of service via FWA, Telet estimates that a subscription would be around GBP35 per

[50] Source: Starlink, accessed 3 February 2025, https://www.starlink.com/.

month. This yields a saving of GBP40 a month (GBP480 a year) per premise connected. Furthermore, Starlink and other satellite providers charge an initial equipment and installation cost (as of January 2025, this is GBP300 for Starlink). However, based on discussions with Telet, we estimate that there would be an equivalent customer premises equipment cost for an FWA Gigabit broadband service of around GBP300 on average covering the equipment and installation (the cost would range from GBP150-500, depending on how far the premise is from the base station.

In respect of estimating general economic benefits of high-speed broadband, we undertook a review of existing studies. From this we identified two key studies of greatest relevance – namely:

- Evaluation of the Superfast Broadband Programme (Ipsos, 2023)
- Role of wireless networks in enhancing digital connectivity in the UK (Intelligens Consulting, 2024).

A detailed summary and review of these reports can be found in Annex A.2 of this report.

We used the results of these third party studies to ensure our economic benefit estimates are anchored in the reality observed in studies with a more detailed scope of work relating to the benefits of superfast broadband connectivity.

From these studies, we identified three key sources of benefit of having access to superfast broadband connectivity:

- **Productivity**. Additional broadband connections enabled by DSA allow productivity gains stemming from increased employment, firm turnover, and wages. As some of these gains would be realised due to other firms relocating to the newly connected area, we use Gross Value Added as a measure of economic impact. We forecast this benefit as an increase in GVA per premises upgraded of GBP20 per annum in line with the findings from the Ipsos study [46]. Furthermore, there are expected to be additional benefits due to a reduction in unemployment in the newly connected areas. The Ipsos study also suggested a reduction in long term unemployment claimants of 9.8 per 10 000 premises upgraded. Using the 25th percentile of income for the UK of GBP1432 per month[51], this yields a benefit of GBP168 400 per annum for every 10 000 premises upgraded.

- **Social welfare**. The social benefits incurred from connectivity can be proxied by an increase in house prices in the areas which gain a high-speed connection. The Ipsos study estimated that house prices see an increase of between GBP1900 and GBP4900 in areas that gain access to superfast connectivity. We have taken the average of these values and assume that there is an equivalent value of GBP3400 increase of value per premise upgraded. The increase in house prices was interpreted as a measure of the gain in social welfare associated with access to superfast and gigabit capable broadband networks on the basis that it represents the amount households are willing to pay for, and therefore should reflect the marginal gain in wellbeing derived from, access to the technology.

- **Additional local economy benefits**. The construction and operation of the new FWA radio sites should overall provide some additional benefits to employment growth and the local economy. As discussed in Section 4.2, we assume that 15% of the base station deployment and ongoing operational costs will generate local economic benefits.

For those premises which would benefit from mobile connectivity as a consequence of use case 1 as well as high-speed FWA connectivity, there is a risk that we may double-count some of the benefits. We estimate there are around 16 000 of these premises out of the 29 000 premises that fall within the addressable market. For the proportion of these premises that we assume take-up FWA services, we

[51] Statista, 'Monthly pay of employees on payrolls in the United Kingdom as of 3rd quarter 2024 by percentile', https://www.statista.com/statistics/1224844/monthly-pay-of-employees-uk/, accessed 10 January 2025

have assumed that 50% of the wellbeing benefit applies. We still consider that the full productivity benefit would apply as most premises upgraded in the superfast broadband programme would have access to high speed mobile services and so the productivity estimates are the additional productivity above this baseline.

5.2.3 Cost of deployment and operation of FWA base station sites

The costs associated with connecting new premises with FWA stem from deployment and operation of network equipment and new radio sites as well as on-premises reception equipment.

Our forecast of the number of FWA site deployments over time is shown in Figure 5-11 below. By 2030, we forecast 360 new deployments are required to serve the addressable market.

Figure 5-11: Number of additional FWA deployments utilising DSA

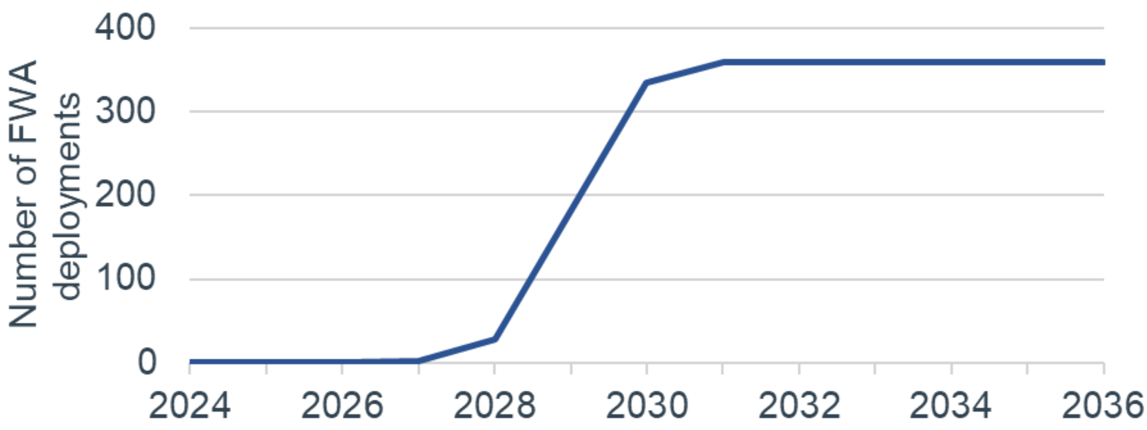


Figure 5-12 shows the cost assumptions we have used for the deployment of an FWA site, based on discussions with Telet, who have indicated a typical cost per premises (UPRN) would be around GBP3500 to 5000 for a full Gigabit broadband service, including the cost of customer premises equipment (in the range of GBP150-500 per home). As this is using the latest technology, we would expect this cost to fall over time.

Figure 5-12: Cost of installation, operation, and maintenance of FWA site

Cost item	Cost as of 2025 (GBP)	Annual price trend
Initial deployment costs		
Radio equipment and ancillaries	100 000	0%
Civils	20 000	Inflation
Backhaul	30 000	0%
Other	25 000	Inflation
Operation and maintenance		
Power	6000	Inflation
Other operations and maintenance	3000	Inflation
Lease	3000	Inflation

For those locations where an FWA site would coincide with a local mobile site (use case 1), we have assumed 50% of the costs above as incremental costs over and above the cost of the local mobile site in order to also provide FWA services. This avoids double counting of costs.

In relation to the cost of on-premises equipment, we have assumed an average cost of GBP300 per premises connected, based on discussions with Telet.

As for use case 1, we have assumed the FWA service providers would already have a core network to which the new FWA sites would be connected.

5.3 Results

The overall benefits gained from the additional access to FWA via a dynamic sharing solution are presented in Figure 5-13 below.

Figure 5-13: Summary of benefits and costs from enabling additional FWA deployments via dynamic sharing of spectrum (2025-2036)

Source of value/cost	Total value 2025-2036 (GBP million)	Net present value 2025-2036 (GBP million)
Competition impact	78.7	58.8
Productivity impact	0.8	0.6
Social welfare benefits	1.6	1.2
Costs	(81.4)	(65.6)
Additional benefits to local economy	12.2	9.8
Total	**11.8**	**4.8**

These results show that there is a net benefit of around GBP5 million in net present value terms over the period 2025-2036. The net present value is as of 2024/2025. Benefits are dominated by the competition benefit since the other benefits only apply to a small subset of the total number of premises (and/or a short period of time).

Please note that our cost estimates may be overstated as we have assumed that Gigabit speeds are required for the FWA solution to be a substitute for satellite. In reality some users may seek lower connection speeds and the costs of provision will be lower.

As discussed above, we also undertook several sensitivities assuming lower levels of take-up and different coverage radii for the FWA base stations. The outcome of this analysis can be seen in Figure 5-14, and the base case is highlighted. It can be seen that the overall net benefit (net present value 2025-2036) lies within the range of between GBP0 to GBP50 million.

Figure 5-14: Summary of benefits and costs from enabling additional FWA deployments via dynamic sharing of spectrum (2025-2036) - under different take-up assumptions

Coverage radius (km)	Take-up rate	Total value 2025-2036 (GBP million)	Net present value 2025-2036 (GBP million)
3	60%	2.3	0.2
4	**60%**	**11.8**	**4.8**
5	60%	26.3	14.1
4	100%	73.4	50.4

6. Use case 3: Additional capacity for national mobile operators

6.1 Introduction

National mobile operators may benefit from having access to additional spectrum in areas in which they have rolled-out 5G coverage, but their competitors have yet to do so. The rollout of 5G is not yet complete, and there are many populated areas in which at least one of the operators is not yet offering high-speed 5G services.

The 3.5GHz band is one of the pioneer bands for 5G and currently supports a maximum individual carrier size of 100MHz. However not all operators hold the full 100MHz of spectrum in this band. The introduction of DSA in LAL spectrum could therefore provide an opportunity for an operator that has deployed a 3.5GHz spectrum in an area to use the spectrum licensed to another national mobile operator that has yet to deploy equipment using the 3.5GHz in that particular area. This would provide improved service (i.e. a speed benefit) to subscribers of the operator making use of the local access spectrum.

6.2 Methodology for quantification of benefits and costs

Our overall approach is to assess the connection speed benefits arising from mobile operators having access to additional spectrum where it is not being used by another mobile operator as a result of the introduction of dynamic access local access licences. From this we deduct the costs associated with utilising additional spectrum, resulting in an overall estimation of the net benefit, as shown in Figure 6-1 below.

Figure 6-1: High-level methodology for quantification of benefits and costs for additional capacity for national mobile operators

(Number of users benefitting) × **(Benefit per user)** – **(Power cost of deploying additional spectrum)**

Our approach is summarised in Figure 6-2 below. This involved estimating the:

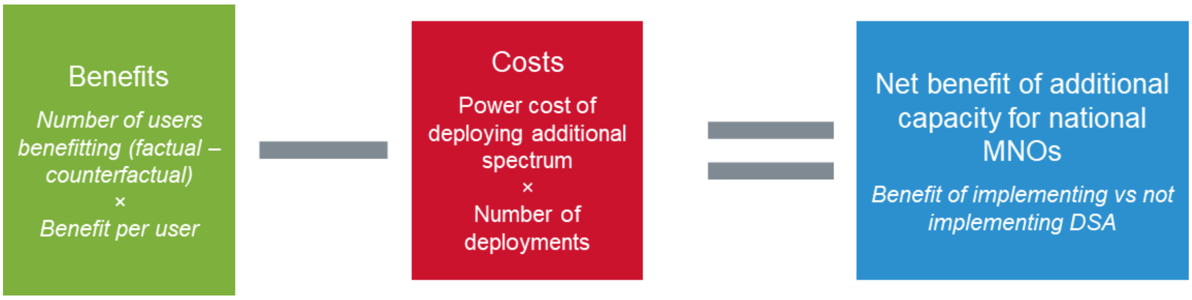
- **Number of users benefitting:** We first calculated the number of mobile users living in locations where their mobile provider would be able to utilise the spectrum of another mobile operator to offer a superior service. We assume that the mobile operators will take advantage of this opportunity wherever it is available, due to the ease with which it can be implemented. As 5G rollouts are completed, we assume that all major towns and cities will be covered by all operators in the near future, and this use case will disappear.

- **Benefit per user:** We assume that the benefit will come predominantly from users experiencing increased speeds where it is implemented. We estimate the size of this benefit from the willingness of users to pay for increased mobile and fixed broadband speeds in the UK and other markets.

- **Power cost of deploying additional spectrum:** We estimated the cost of implementation from the cost of the additional power used by radios when utilising additional spectrum.

The overall net benefit of this use case is calculated from subtracting the costs of deploying additional spectrum from the estimate of benefits.

Figure 6-2: Methodology for calculating net benefit for additional capacity for national mobile operators



As described in Section 6.1 above, the main benefit of this use case is the national mobile operators being able to offer higher speeds to subscribers in some locations.

The main cost is from the additional power used by RAN equipment for greater bandwidths.

6.2.1 Number of users benefitting

To determine the benefits of this use case, we must first estimate the number of users that can benefit.

In reality two types of users will benefit – those living in the area and other mobile users visiting the area. We focus on estimating the benefit accrued by people living in the area since they will gain the greatest benefit.

Due to the maximum carrier size of 100MHz for the 3.5GHz band, only customers of operators with less than 100MHz are likely to benefit significantly from this use case. We assume DSA implementation in 2027, by which time, Vodafone and Three will have merged, and between them have greater than 100MHz. It is possible that VMO2 may acquire additional 3.5GHz spectrum as a remedy from the merger and may therefore also have greater than 100MHz of spectrum in this band. EE, however, has 80MHz of 3.5GHz spectrum and its customers may therefore be able to benefit.

In towns/cities where EE has deployed 3.5GHz but at least one of VF3 or VMO2 has not, DSA would enable EE to use an additional 20MHz of spectrum on its sites, so that it uses a full 100MHz carrier.

We analysed data detailing whether each of the national mobile operators has deployed 5G in 120 major towns/cities in the UK to yield a set of 22 locations in which either O2 or Vodafone and Three do not currently offer 5G services[52].

A total of 1 446 501 people live in these locations including 401 549 EE (and its MVNOs) customers, assuming a market share of 27.8% for EE. [53] As the national mobile operators continue to rollout 5G, the number of locations not covered by O2 or Vodafone and Three will decrease. In our base case, we assume that by 2030, the addressable market will reduce to zero, as all locations are covered by all the national mobile operators. We have also considered sensitivities in which rollouts are completed in 2028 or 2032.

Without DSA, this use case is not possible because under the existing process national mobile operators are unlikely to give approval to competitors to make use of their spectrum in major towns/cities

---

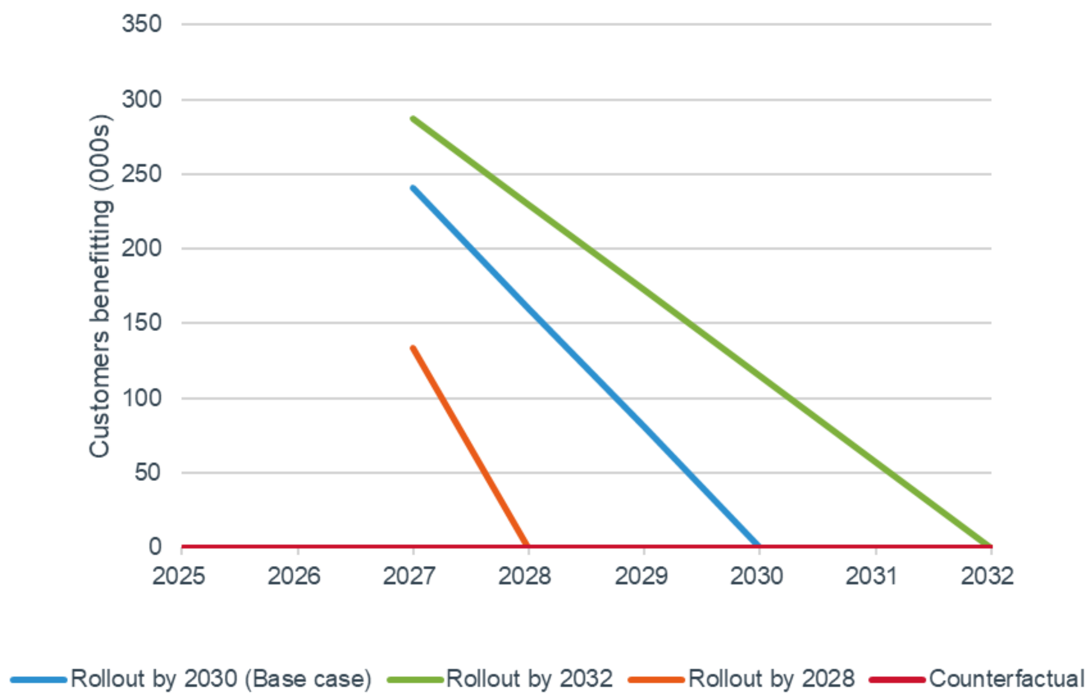
[52] 5g.co.uk, '5G coverage map checker', accessed 3 March 2025, https://5g.co.uk/coverage/

[53] Uswitch, 'UK mobile phone statistics 2024', accessed 3 March 2025, https://www.uswitch.com/mobiles/studies/mobile-statistics/

they are likely to deploy in by 2030. The counterfactual is therefore that no customers benefit from this use case.

The number of users benefitting from this use case under each of these assumptions is shown in Figure 6-3 below.

Figure 6-3: Number of users that would benefit under 5G rollout scenarios



We assume that EE will implement this use case in all locations in which users can benefit, due to the ease with which it can be implemented.

6.2.2 Benefit per user

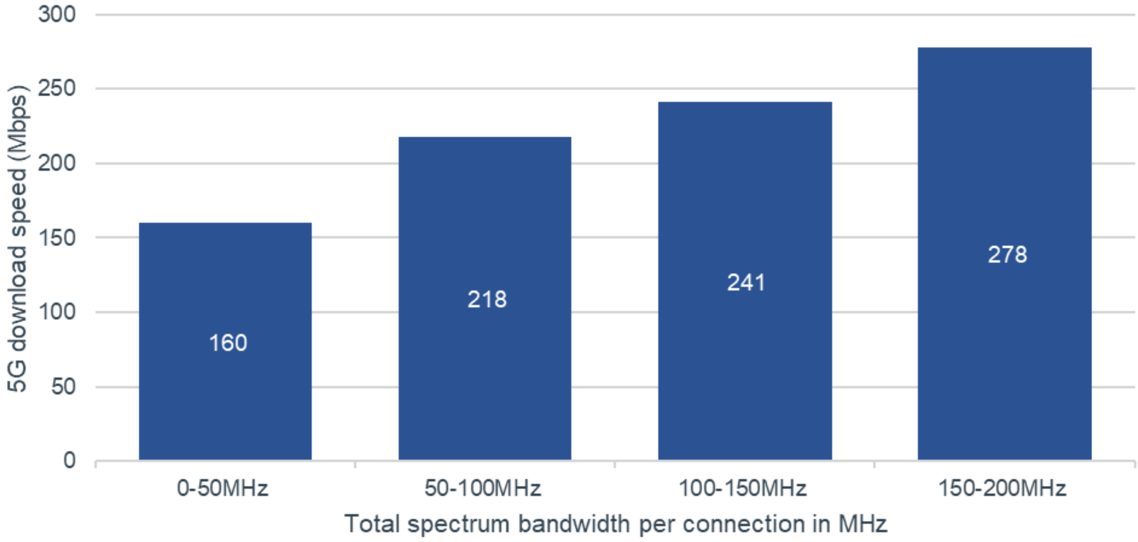
To estimate the benefit of this use case to each mobile user, we must first understand the size of the speed increase that customers would receive where it can be implemented and then estimate the value of this additional speed to users.

6.2.2.1 Size of speed impact

To understand the speed impact of the additional 20MHz that EE could utilise on relevant sites, we have analysed data from Opensignal that relates connection bandwidth to speed. Opensignal has studied the typical 5G download speed for a range of bandwidths and these are shown in Figure 6-4 below.[54]

[54] Opensignal, 'More usable spectrum boosts the 4G and 5G experience', accessed 3 March 2025, https://www.opensignal.com/2023/06/29/more-usable-spectrum-boosts-the-4g-and-5g-experience

Figure 6-4: 5G download speed with spectrum bandwidth per connection [Source: Opensignal]



The increase in speed per MHz of bandwidth for transition between each of Opensignal's data points is shown in Figure 6-5 below.

Figure 6-5: Increase in speed per MHz of bandwidth [Source: Opensignal]

Bandwidth transition (MHz)	Download speed increase (Mbps/MHz)
0-50 to 50-100 (Assumed 25-75)	1.16
50-100 to 100-150 (Assumed 75-125)	0.46
100-150 to 150-200 (Assumed 125-175)	0.73

To estimate the speed increase for EE's customers, we assume that Opensignal's data is representative of a connection using a bandwidth in the middle of the range, i.e., the 50-100MHz speed is representative of the speed for a bandwidth of ~75MHz. EE has 80MHz of 3.5GHz spectrum and the speed it can offer with this spectrum would therefore be ~218Mbps.

Where EE can make use of local access licence spectrum, the increase in bandwidth for its customers would be from 80MHz to 100MHz. Conservatively, the speed increase per MHz can be estimated from the transition between 50-100MHz and 100-150MHz (Assumed 75-125MHz) as 0.46Mbps/MHz. The total increase for customers would be 9.2Mbps. This is a 4.2% increase to the speed we assume EE can offer with 80MHz.

6.2.2.2 Value of speed impact

National mobile operators in the UK do not typically offer data packages differentiated by speed. It is therefore not possible to use current UK mobile data pricing to determine the value of this speed increase to customers. We have instead considered the results of two other methods, one that considers the value of speed to mobile customers in another country (Finland), and one that considers the value of fixed broadband speeds to UK customers.

Finland is one of a small subset of countries in which packages differentiated by speed are available. The prices for rolling contracts offered by Elisa and Telia containing unlimited data are shown below in Figure 6-6 below.

Figure 6-6: Mobile data package prices – Elisa and Telia

Operator	Monthly contract price (EUR)		
	300Mbps	600Mbps	1000Mbps
Elisa	37.99	42.99	50.99
Telia	37.99	44.99	50.99
Average	**37.99**	**43.99**	**50.99**

There is a 15.8% increase in the average price for a 100% increase in speed from a 300Mbps package to a 600Mbps package. Scaling this to the 4.2% increase in speed available to EE customers under this use case gives an additional value of 0.67%.

In contrast to mobile plans, UK broadband is typically priced based on speed. We have investigated BT's broadband pricing to analyse the value of speed to fixed line customers in the UK. The typical pricing for full fibre broadband with various speeds is shown in Figure 6-7 below.

Figure 6-7: Full fibre fixed packages prices – BT

Operator	Monthly contract price (GBP)				
	74Mbps	150Mbps	300Mbps	500Mbps	900Mbps
BT	25.99	29.99	30.99	31.99	36.99

There is a 15.4% increase in the price for a ~100% increase in speed from a 74Mbps package to a 150Mbps package, similar to the increase in Finland from a 300Mbps to 600Mbps mobile package. However, the increase from 150Mbps to 300Mbps is much smaller, only 3.3%.

In our view, the method considering mobile prices in Finland is more representative of the value of speed increases to UK mobile customers. This method compares the mobile markets of two different countries, but there is more similarity between how data is consumed in the UK and Finnish mobile markets than between the fixed and mobile markets in the UK.

The postpaid monthly ARPU in the UK in Q3 2024 was GBP16.17.[55] Assuming a 0.67% increase in this price gives a benefit of GBP0.11 per month per EE customer that can take benefit from the increased speeds.

6.2.3 Cost of increased power consumption

EE's RAN equipment will support a carrier size of 100MHz and it can therefore utilise the additional 20MHz of spectrum without any additional hardware. The costs of implementing this use case therefore come predominantly from the increase in power required by sites using additional spectrum. We must

[55] Ofcom, 'Telecommunications Market Data Update Q3 2024', 23 January 2025.

therefore consider the power cost per site of deploying an additional 20MHz of 3.5GHz spectrum, and the number of sites which would use the additional spectrum in the relevant towns and cities.

6.2.3.1 Power cost per site

Based on our experience modelling mobile networks, we estimate that the increase in required power from using the additional 20MHz of spectrum available would be ~60W per radio, for a total of 180W for site with three sectors. We assume that the additional spectrum would be used for 12 hours per day on average.

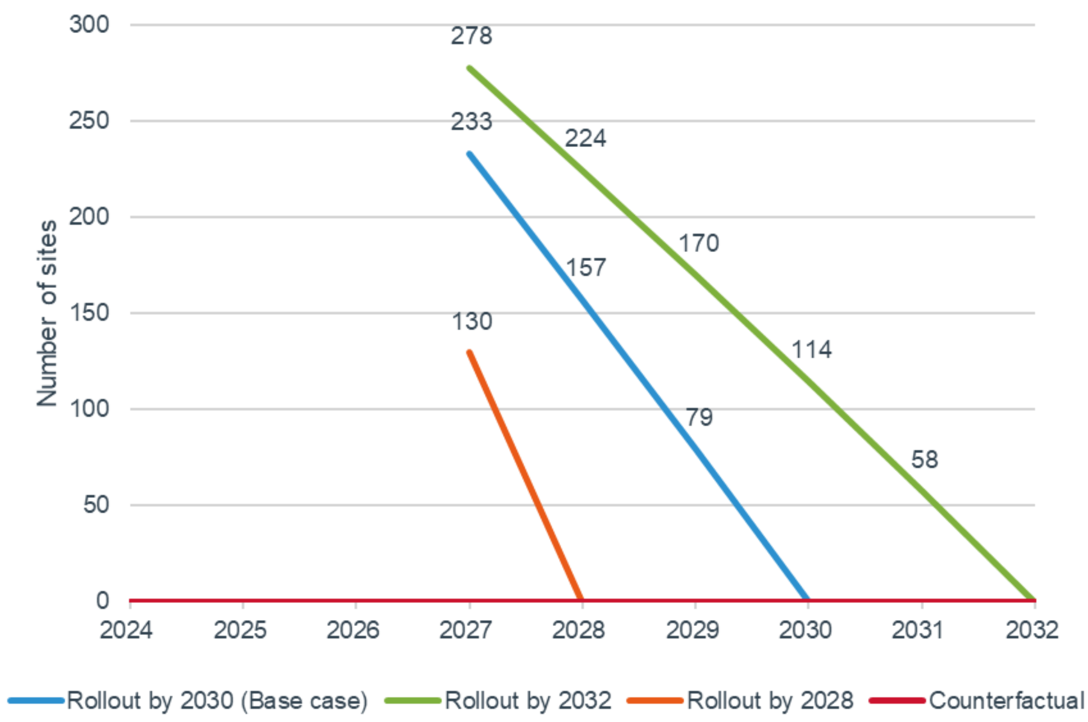
Finally, we assume an electricity cost of GBP0.25 per kWh, based on the current energy price cap[56], plus inflation.

6.2.3.2 Number of sites utilising additional spectrum

To calculate the number of sites that would utilise additional spectrum, we assume that EE's sites are approximately evenly distributed with population. The number of sites is therefore linearly dependent on the population of the locations benefiting from the use case.

We estimated that EE has ~18 000 total sites, and we multiplied this by the proportion of the UK's population (~68 million) that may benefit from this use case, calculated as explained in Section 6.2.1. As 5G rollouts continue to progress and the proportion of the population that can benefit decreases, the number of sites also decreases, as shown in Figure 6-8 below.

Figure 6-8: Number of sites utilising additional spectrum under 5G rollout scenarios



[56] Ofgem, 'Energy price cap', accessed 3 March 2025, https://www.ofgem.gov.uk/energy-price-cap

6.3 Results

The overall benefits from implementing DSA for LALs to enable additional capacity for national mobile operators are presented in Figure 6-9 below.

Figure 6-9: Summary of benefits and costs from enabling additional capacity for national mobile operators via dynamic sharing of spectrum (2025-2036)

Source of value/cost	Total value 2025-2036 (GBP million)	Net present value 2025-2036 (GBP million)
Productivity benefit	0.7	0.6
Costs	(0.1)	(0.1)
Total	**0.6**	**0.5**

These results show that there is a net benefit of around GBP0.5 million in net present value terms over the period 2025-2036. The net present value is as of 2024/2025.

As discussed above, we also undertook sensitivities assuming faster or slower completion of 5G rollouts to all major towns and cities. The outcome of this analysis is provided in Figure 6-10 below and the base case is highlighted. It can be seen that the overall net benefit (net present value 2025-2036) lies within the range of between GBP0.1 to GBP1 million.

Figure 6-10: Summary of benefits and costs from enabling additional capacity for national mobile operators via dynamic sharing of spectrum (2025-2036) – under different 5G rollout assumptions

5G rollout completion date	Total value 2025-2036 (GBP million)	Net present value 2025-2036 (GBP million)
2028	0.2	0.1
2030 (Base case)	**0.6**	**0.5**
2032	1.0	0.9

7. Use case 4: Short-term assignments for events

7.1 Introduction

Festivals and other events may benefit from short-term access to spectrum for private networks. The number of people in an event location is typically greatly increased for the duration of the event by the presence of the attendees. Public mobile networks are generally designed to serve the traffic that is typical year-round in an event location, rather than for the peak during the event. For this reason, public mobile networks often become highly congested at events.

The introduction of DSA in SAL and/or LAL spectrum would enable private networks to be deployed by smaller organisations (e.g. local mobile providers) at these events to provide additional capacity for high priority communications but many of these opportunities are not realised (except for large events) because of the complexities associated with obtaining SAL or LAL licences – especially given they will only be used for a short period of time e.g. a weekend over which the festival is running. We understand that Ofcom is planning to automate front-line licence management, and this should lead to faster processing of licences. Nonetheless many small to mid-scale events may not have organised their connectivity requirements well ahead of the timescale needed to obtain an appropriate spectrum licence. Additionally Ofcom's current licence fee structure is based on charging fees on an annual basis, and this is likely to significantly constrain demand for short-term uses.

One example key use of connectivity at events is that of point of sales (POS) terminals. Ensuring that POS terminals can reliably connect to the Internet for credit card authorisations would generate benefits to suppliers of services and catering at events, to attendees and to event organisers.

Note that we have undertaken a separate assessment of the to the use-case of the national mobile operators using SALs to provide surge capacity at events. This is presented in Annex B to this report.

7.2 Methodology for quantification of benefits and costs

Our overall approach is to assess the benefits arising from introducing reliable connectivity for POS terminals as a result of the introduction of dynamic access to spectrum allocated for local access licences and shared access licences. From this, we deduct the costs associated with providing this connectivity, resulting in an overall estimation of the net benefit as shown in Figure 7-1 below.

Figure 7-1: High-level methodology for quantification of benefits and costs for short-term assignments for events

(Number of events served) × (Benefit per event) – (Cost of connecting events)

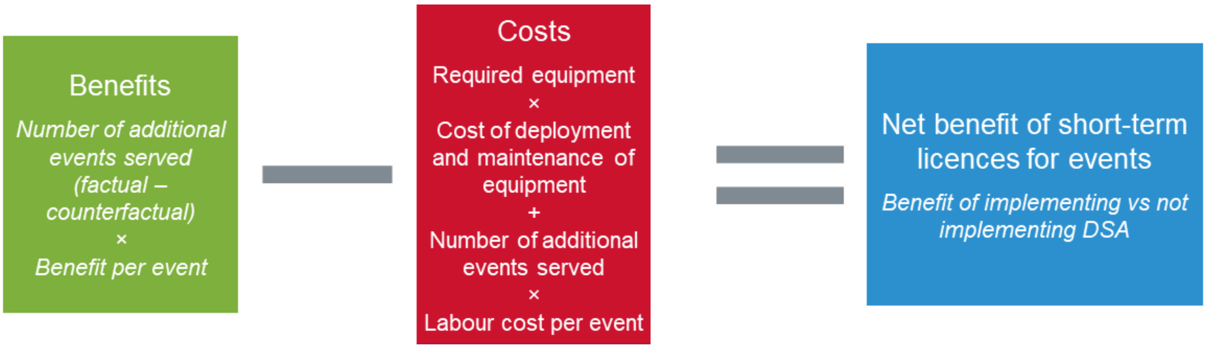
Our approach is summarised in Figure 7-2 below. This involved estimating the:

- **Number of additional events served:** We first estimated the number of events large enough to justify a short-term deployment whilst at the same time are not large enough for an existing solution (public mobile or SAL). We then estimated the number of these events which would benefit from a private network using DSAL spectrum to ensure reliable operation of POS terminals.
- **Benefit per event:** We estimated the GVA of additional spending at events enabled by this use case based on the amount currently spent at events, and the attendance at the events which would be served.

- **Cost of deployment and maintenance of equipment:** We estimated the cost of the equipment required to serve the events.
- **Labour cost per event:** We estimated the labour cost of providing connectivity per event.

The overall net benefit of this use case is calculated from subtracting the costs of purchasing and operating radio base station equipment at events from the estimate of benefits.

Figure 7-2: Methodology for calculating net benefit for additional capacity for short-term assignments for events



As described in Section 7.1 above, the main benefit of this use case is increased reliability of connectivity to POS terminals at events.

The main costs are from private network providers purchasing and equipment and the labour required to operate it.

7.2.1 Number of events served

The first input to calculating the benefits and costs of this use case is the number of events which can be served.

The Events Industry Forum (EIF) publishes data on the locations and attendance of music festivals in the UK.[57] Its data contains a total of 778 festivals for which capacity data was available, with a total capacity of ~14 million.

EIF and Business Visits & Events Partnership reported that a total of 7000 events major outdoor events took place in the UK in 2011.[58] In 2018, the EIF reported a total attendance of 141.5 million at outdoor events in the UK in 2018. [59] Given that the music festival data contains ~10% of the total number of events estimated by the EIF, and ~10% of total attendance, we assume that the data forms a representative sample of all events in the UK.

We analysed the festivals data and assumed that events with between 500 and 10 000 attendees are most likely to benefit from this use case. Events with a larger number of attendees would likely be able to implement an existing solution, and events with fewer than 500 attendees are probably too small to justify the deployment of a private network for this use case.

[57] Events Industry Forum, 'How many Music Festivals are there in the UK?', accessed 3 March 2025, https://www.eventsindustryforum.co.uk/Making-Festivals-Count/

[58] Events Industry Forum, Business Visits & Events Partnership, 'Opportunities for Growth in the UK Events Industry', October 2011.

[59] Events Industry Forum, 'Value of Outdoor Events 2018', October 2019.

Under this assumption, 46.4% of events are of an appropriate size for this use case, and these contain 14.6% of total attendance. Assuming that there are 7000 events per year, 3248 of these are of appropriate size.

Finally, we assume that only a proportion of these events experience issues with their POS terminals under their existing internet connectivity solution (typically public mobile networks). In the base case, we assume 10% of events experience issues and would require a private network solution, for a total of 325 events per year. We also consider sensitivities of 5% and 15%.

7.2.2 Benefit per event

To estimate the benefit of this use case, we first estimated the current GVA resulting from purchases at the events served.

In its 2018 report, the EIF reported a total spend of GBP39.4 billion on-site at outdoor events and a GVA of GBP30.4 billion. We considered only spending that would occur over POS terminals at events e.g., food and drink and disregarded other spending e.g. ticket sales, to estimate a GVA of GBP10.5 billion relevant to this use case, inflated to GBP13.1 billion in 2024/2025 terms.

As detailed in Section 7.2.1, 14.6% of total attendance capacity is contained by events of an appropriate size for this use case and we use this to estimate the proportion of total spend at the events served. Assuming that spending is higher per attendee is typically higher at larger events, we apply a factor of 50% for the purpose of estimating GVA at the events served.

We then applied the assumption that the use case will be implemented at the 10% of events that experience POS terminal issues, to give a total GVA at the events served of GBP102 million in 2027 in the base case.

We assume that 1% additional spending would occur if POS terminals were reliable at these events, due to both faster transactions and fewer failed transactions where the card transaction is not replaced by a cash purchase.

7.2.3 Costs of providing connectivity to events

The costs of providing connectivity to events result from both the equipment required and the labour cost of deploying it.

To determine the costs of the required equipment, we estimate the number of events which may occur simultaneously. As explained in Section 7.2.1, we estimate that 325 events would be covered per year under this use case. Events are concentrated across the summer months, as shown in the EIF's report.[59] To account for this, we assume that events are distributed over 30 weeks of the year, and therefore, a total of 11 radios would be required. Equipment maintenance is a recurring annual expense for each radio, and labour costs are incurred for each event to install and set-up the private network base station site.

Figure 7-3 below details our estimates for the costs associated with deploying radios for this use case, based on our experience of modelling mobile networks.

Figure 7-3: Cost of equipment, maintenance and labour for mobile equipment operated by a private network provider

Cost item	Cost as of 2025 (GBP)	Annual price trend
Initial deployment costs		
Initial deployment cost - radio equipment, civils and ancillaries	20 000	0%
Recurring costs		
Maintenance (per radio, per year)	1000	Inflation
Labour (per event)	1000	Inflation

7.3 Results

The overall benefits from implementing DSA for SALs and LALs for short-term assignments for events are presented in Figure 7-4 below.

Figure 7-4: Summary of benefits and costs from enabling short-term assignments for events via dynamic sharing of spectrum (2025-2036)

Source of value/cost	Total value 2025-2036 (GBP million)	Net present value 2025-2036 (GBP million)
Productivity benefit	11.3	8.7
Costs	(4.1)	(3.2)
Total	**7.2**	**5.5**

These results show that there is a net benefit of around GBP6 million in net present value terms over the period 2025-2036. The net present value is as of 2024/2025.

As discussed above, we also undertook sensitivities assuming a greater or lesser number of events experience connectivity issues and would benefit from this use case. The outcome of this analysis is provided in Figure 7-5 and the base case is highlighted. It can be seen that the overall net benefit (net present value 2025-2036) lies within the range of between GBP3 to GBP9 million.

Figure 7-5: Summary of benefits and costs from enabling short-term assignments for events via dynamic sharing of spectrum (2025-2036) – under different assumptions of number of events served

Events served per year	Total value 2025-2036 (GBP million)	Net present value 2025-2036 (GBP million)
162	3.6	2.8
325 (Base case)	**7.2**	**5.5**
487	10.8	8.3

8. Use case 5: Short-term assignments for TV content production

8.1 Introduction

DSA would allow TV content producers[60] to use spectrum at short notice to enhance broadcasts via the use of multicamera set-ups run communicating through a private 5G base station, without the need for cabling teams and satellite trucks and may simplify complicated outdoor broadcasts. We have identified three categories of TV content production that may benefit from short term access to spectrum for private networks. These are breaking news, low-tier sports and major events.

Breaking news events typically occur with little prior warning and can happen anywhere across the UK. DSA would allow content producers to obtain a spectrum licence in less than the time it takes them to travel to a location to film, which is not possible under the current licencing regime. This would reduce content producers' reliance on satellite trucks.

Low-tier sports are often filmed using a single camera. Where multiple cameras are used, cabling is typically required which is an additional expense to set-up. Short-term licences would reduce the need for cabling and enable more broadcasts of low-tier sports using multiple camera set-ups. This may in turn also enable more low-tier sports events to be held and broadcast, however we have not sought to include this impact as part of our quantitative assessment.

Major events require a full outdoor broadcast including cabling. These could be simplified, and production costs could be reduced through the use of private 5G base stations.

One further challenge for TV content producers under the existing licensing regime is that for SALs they would be required to adopt the same timing and synchronisation as other 5G private network users. For such broadcasting use, the majority of traffic would be in the uplink from the cameras to the private 5G base station – this is the opposite to many other uses where the traffic is predominantly downlink. Our proposed dynamic access solution would allow different uplink/downlink splits to be adopted – with the base stations informing the DSA Server of the required split and the DSA Server than taking account of the different splits to determine the separation distances required between users operating on the same and adjacent frequency channels and could then make a spectrum assignment accordingly.

8.2 Methodology for quantification of benefits and costs

Our overall approach is to assess the benefits arising from a reduction to TV content production costs resulting from the introduction of dynamic access to spectrum allocated for shared access licences. From this benefit, we deduct the costs associated with providing this connectivity resulting in an overall estimation of the net benefit as shown in Figure 8-1 below.

Figure 8-1: High-level methodology for quantification of benefits and costs for short-term assignments for TV content production

(Number of events served) × (Benefit per event) – (Cost of connecting events)

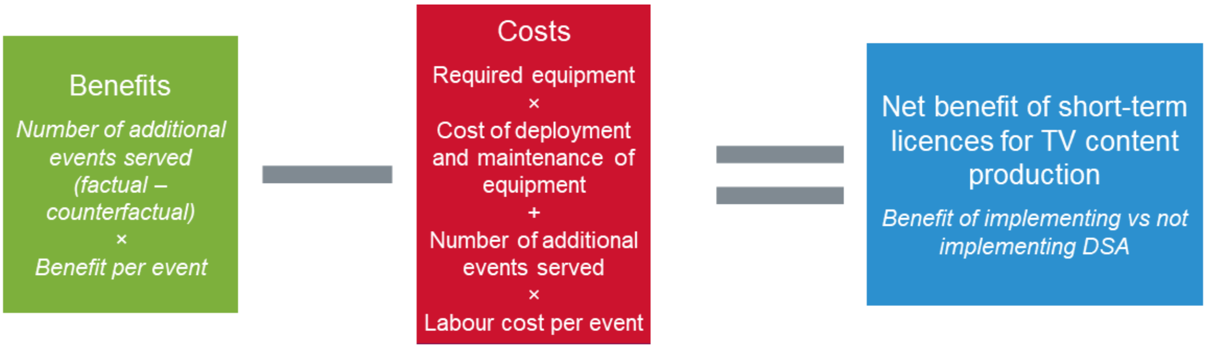
[60] See, for example, 'BBC response to the Ofcom consultation: Expanding Access to Shared Spectrum', 18 September 2024, accessed at https://www.ofcom.org.uk/siteassets/resources/documents/consultations/category-1-10-weeks/consultation-supporting-increased-use-of-shared-spectrum/responses-2/bbc.pdf?v=384206

Our approach is summarised in Figure 8-2 below. This involved estimating the:

- **Number of events served:** We first estimated the number of each type of content production events for which a short-term deployment would reduce the costs of production.
- **Benefit per event:** We estimated the benefit per event from the production costs savings made possible by a short-term deployment, comparing the cost of private networks to existing solutions.
- **Cost of deployment and maintenance of equipment:** We estimated the cost of the equipment required to serve the production events.
- **Labour cost per event:** We estimated the labour cost of providing connectivity per production event.

The overall net benefit of this use case is calculated from subtracting the costs of purchasing and operating RAN equipment at TV production events from the estimate of benefits.

Figure 8-2: Methodology for calculating net benefit for additional capacity for short-term assignments for TV content production



As described in Section 8.1 above, the main benefit of this use case is from the savings of TV content production costs.

The main costs result from the content producer purchasing the 5G base stations and the labour required to operate it at events.

8.2.1 Number of events served

The first input to calculating the benefits and costs of this use case is the number of content production events which could be served.

We discussed our three categories of TV content production events with industry stakeholders to understand the likely demand for this use case. Figure 8-3 below contains our estimate for the number of events for which cabling/satellite truck/outdoor broadcast are currently used annually. DSA would enable cost savings for each of these events by replacing the existing solution at a lower cost. We conducted sensitivity analysis on our estimated number of events and these assumptions are also shown in Figure 8-3.

Figure 8-3: Annual number of TV filmed events for which dynamic access spectrum would enable cost savings

Event type	Breaking news	Low-tier sports	Major events
25% fewer events	250	225	75
Base case	333	300	100
25% more events	417	375	125

There are many additional breaking news and low-tier sports events which currently use a single camera set-up, because the costs of existing multicamera solutions are prohibitive. However, as private networks would be a cheaper solution, many of these content productions could be enhanced at a lower cost. For example, we estimate that there are ~700 low-tier sports events that use a single camera set-up per year and a similar number of breaking news events.

8.2.2 Benefit per event

To estimate the benefit of this use case at a content production event, we determine the cost savings resulting from replacing a more expensive solution for multicamera set-ups with a private network, using dynamic access spectrum. The cost savings from replacing existing solutions are show in Figure 8-4 below.

Figure 8-4: Cost savings by event type based on existing multicamera solution

Event type / Cost item	Cost as of 2025 (GBP)	Annual price trend
Breaking news / Cabling (labour)	5000	Inflation
Low-tier sports / Cabling (labour)	5000	Inflation
Major events / Full outdoor broadcast	10 000	Inflation

As explained in Section 8.2.1, there are many events for which an existing solution is not utilised, due to prohibitive costs. The lower costs of using a private network solution may lead to many of these productions being enhanced. This provides a benefit to consumers from a higher quality news or entertainment product. There may also be a productivity benefit for content producers who might be able to generate additional revenue from these improved products. However, it is not possible to quantify this benefit.

8.2.3 Costs of providing connectivity to events

The costs of providing connectivity to content production events result from both the equipment required and the labour cost of deploying it.

The amount of equipment required was estimated based on the number of production events connected. In the base case, we assume that a total of 40 5G base stations are required. This number changes proportionally with the number of production events connected.

Equipment maintenance is a recurring annual expense for each radio, and labour costs are incurred for each production event.

Figure 4-17 shows our estimates for the costs associated with deploying radios for this use case, based on our experience of modelling mobile networks.

Figure 8-5: Cost of equipment, maintenance and labour for mobile equipment

Cost item	Cost as of 2025 (GBP)	Annual price trend
Initial deployment costs		
Initial deployment cost - radio equipment, civils and ancillaries	20 000	0%
Recurring costs		
Maintenance (per radio, per year)	1000	Inflation
Labour (per event)	1000	Inflation

8.3 Results

The overall benefits from implementing DSA for SALs for short-term assignments for TV content production are presented Figure 8-6 below.

Figure 8-6: Summary of benefits and costs from enabling short-term assignments for TV content production via dynamic sharing of spectrum (2025-2036)

Source of value/cost	Total value 2025-2036 (GBP million)	Net present value 2025-2036 (GBP million)
Productivity benefit – Breaking news	19.1	14.7
Productivity benefit – Low-tier sports	17.2	13.3
Productivity benefit – Major events	11.4	8.8
Costs	(9.7)	(7.6)
Total	**38.0**	**29.3**

These results show that there is a net benefit of around GBP30 million in net present value terms over the period 2025-2036. The net present value is as of 2024/2025.

As discussed above, we also undertook sensitivities regarding our estimate of the number of TV content production events that would benefit from this use case. The outcome of this analysis is provided in Figure 8-7 below and the base case is highlighted. It can be seen that the overall net benefit (net present value 2025-2036) lies within the range of between GBP21.8 to GBP36.4 million.

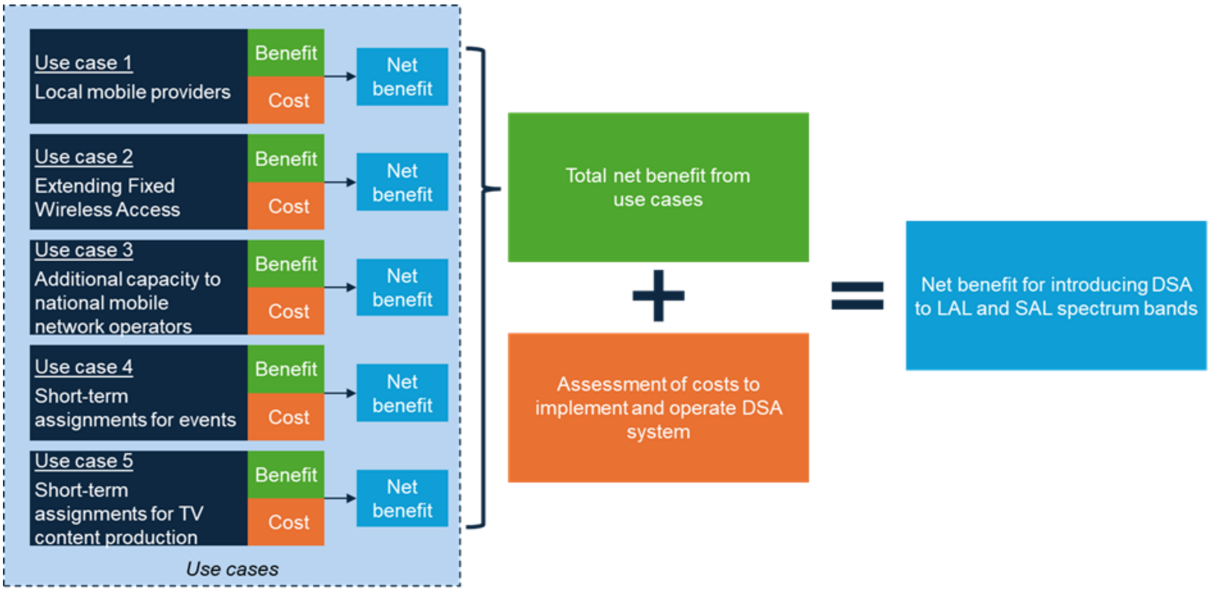
Figure 8-7: Summary of benefits and costs from enabling short-term assignments for TV content production via dynamic sharing of spectrum (2025-2036) – under different assumptions of number of events served

Events served per year (Breaking news / Low-tier sports / Major events	Total value 2025-2036 (GBP million)	Net present value 2025-2036 (GBP million)
25% fewer events (250/225/75)	28.5	21.9
Base case (333/300/100)	**38.0**	**29.3**
25% more events (417/375/125)	47.5	36.6

9. Overall benefits assessment

We estimate the overall benefit of introducing DSA in the local access and shared access spectrum bands by totalling the net benefits from each of the use cases and subtracting the costs of implementing DSA in these bands, as shown in Figure 9-1 below.

Figure 9-1: Summary of approach to quantifying net benefits of DSA in LAL and SAL spectrum bands



9.1 Summary of net benefits from use cases

A summary table containing the total net benefits of each of the use cases is shown in Figure 9-2 below. The total net benefit from all use cases is around GBP105 million in net present value terms over the period 2025-2036. Taking account of the sensitivity analysis on key assumptions, the value of the total net benefit from all of the five use cases is estimated to be in the range of GBP60 to 165 million.

Figure 9-2: Summary of benefits of each use case under base case assumptions

Use case	Total value 2025-2036 (GBP million)	Net present value 2025-2036 (GBP million)	Range of NPV 2025-2036 (GBP million)
Local mobile coverage	95.0	67.4	37.2 - 67.4
Extending the reach of fixed wireless access (FWA)	11.8	4.8	0.2 - 50.4
Additional capacity for national mobile operators	0.6	0.5	0.1 - 0.9
Short-term assignments for events[61]	7.2	5.5	2.8 - 8.3
Short-term assignments for TV content production	38.0	29.3	21.9 - 36.6
Total	**152.7**	**107.6**	**62.3 – 163.6**

One further benefit that could be enabled in the event that the national mobile operators were allowed to make use of SAL spectrum bands is the use of this spectrum to provide additional 'surge' capacity at events (e.g. concerts and festivals). Annex B presents further details of this benefit – we estimate it could amount to GBP9 million (net present value 2025-2036). We have not included this use case in our overall benefit as the use of SAL spectrum by the mobile operators is not currently envisaged by Ofcom and was not part of our regulatory proposals, but we note it is a potential upside to the total estimation of benefits from the five modelled use cases.

9.2 Cost of implementing DSA

We have estimated the costs of implementing DSA in the LAL and SAL spectrum bands as follows:

- **Development of the required regulatory framework:** Ofcom would incur staffing costs designing the regulatory framework required before DSA could be implemented in these bands.
- **Development and running of the DSA Server:** Costs associated with developing the bespoke DSA server and ongoing operational costs.
- **Middleware for radio to DSA Server communication:** Software would need to be developed enabling the radios to communication with the DSA Server.
- **Oversight of DSA:** Ofcom will also incur staff cost to oversee the new licensing process. We expect the issuance of DLAL and DSAL licences to be automated using Ofcom's existing licensing systems. Ofcom would also need to oversee the operation of the systems including appointing and

[61] We also separately considered the benefits that may arise from the national mobile operators being able to use SALs to provide 'surge' capacity at events. This is discussed in Annex B of this report.

overseeing DSA Server providers. However, beyond the initial establishment of the regime, we expect that these costs will be comparable to those Ofcom currently incurs manually processing local access and shared access licences and these costs are therefore not considered further.

9.2.1 Development of the required regulatory framework

We have assumed that Ofcom will require the equivalent of two full time employees working for two years (2025/60 and 2026/27) to develop and implement the required regulatory framework for DSA. We assume the salary for each FTE employee on average would be GBP75 000 and the full cost of the employee (including employer's NI, benefits, computer equipment, share of office costs) would be double this i.e. around GBP150 000 per FTE.

Management time would also be required for the review and finalisation of the proposals. Additionally, Ofcom's legal team would also be involved. To model these costs, we assume an additional 50% on top of the modelling costs for the two FTEs.

9.2.2 Development and operation of the DSA Server

From discussions with DSA system providers, we have modelled the costs of developing and operating the DSA server as follows:

- Annual operational cost for the platform – including hosting services, hosting services, system monitoring, NOC and technical support – modelled as USD1 000 000 (approximately GBP800 000) per annum), increasing with inflation. For the purposes of our modelling, we have assumed three separate organisations will develop DSA Servers for the LAL and SAL spectrum bands.

- Licensing fee per radio – this would be to recover historic costs and cover future costs for R&D, product development and sales, general and admin costs associated with these activities. This has been modelled as a one-off licensing fee per radio (paid upon radio deployment and activation) valid for the lifetime of the equipment. The amount modelled is USD30 per radio (approximately GBP25 per radio), increasing with inflation.

9.2.3 Middleware for radio to DSA Server communication

The software to enable the exchange of messages between the radios (base stations) operating in the LAL and SAL bands will need to be developed and tested. Although we expect radio equipment to be provided by a range of manufacturers (or specialist software developers on behalf of the manufacturers), we do not expect each one will develop their own middleware. We have assumed that the middleware software is developed by five different organisations at a cost of ~GBP500 000 per developer, incurred in 2026.

9.2.4 Total DSA implementation costs

The total costs of implementing DSA are summarised in Figure 9-3 below.

Figure 9-3: Summary of costs for implementing DSA

Category of expense	Total cost 2025-2036 (GBP million)	Net present value 2025-2036 (GBP million)
Development of the required regulatory framework	0.9	0.9
Development and running of the DSA Server	27.7	21.4
Middleware for radio to DSA Server communication	2.6	2.4
Additional ongoing staffing costs for Ofcom	-	-
Total	**31.2**	**24.7**

9.3 Overall net benefit assessments

The overall net benefit of introducing DSA in the local access and shared access bands is calculated from subtracting the costs of implementation from the net benefits of the use cases. This calculation is shown in Figure 9-4 below.

Figure 9-4: Overall net benefit of implementing DSA

Benefit / cost	Total value 2025-2036 (GBP million)	Net present value 2025-2036 (GBP million)
Net benefits from use cases	152.7	107.6
Total costs of implementation	31.2	24.7
Total	**121.4**	**82.9**

The overall net benefit of introducing dynamic access to the local access and shared access spectrum bands is estimated to be around GBP80 million in net present value terms over the period 2025-2036. The net present value is as of 2024/2025.

Taking account of the uncertainties over key assumptions used in our estimations of the benefits of individual use cases, we note that the overall net benefit could range from around GBP35 million to GBP140 million (net present value 2025-2036, in 2024/2025 terms).

We note that this is a quantitative estimate of the benefits based on assessing five potential use cases. There could be other use cases that we have not considered – and, furthermore, those five use cases have wider benefits that are not quantifiable (for example improved television viewer experience, promotion of lower tier sports).

9.4 Future adoption of DSA

DSA is likely to be adopted in many frequency bands in the coming 30 years. It is important that the UK plays a leading role in the development of this technology and Ofcom introducing DSA in the LAL and SAL spectrum bands as well as the 6GHz band would represent a major step forward for the UK.

As an illustration of the future potential benefit of DSA, we have compared the additional economic value that could be generated from the application of DSA to the 1800MHz band with the amounts currently being paid in annual spectrum fees by the national mobile operators for this band (which provides a lower bound indicator of the value of the spectrum). We estimate that DSA could yield an additional 5% of economic value from the spectrum. If this uplift applied to all spectrum (where it is likely to be a conservative estimate), DSA would have the potential to yield around GBP2.5 billion per annum in economic value for the UK.

10. Regulatory implementation of DSA

In this section we discuss how the dynamic sharing mechanism as summarised in Section 2 can be implemented under the current legal and regulatory framework for the licensing of electronic communication systems.

We present an overview of the current regulatory implementation of LALs and SALs in Section 10.1 and then discuss the regulatory implementation of the proposed dynamic assignment mechanism in Section 10.2. We present a roadmap for implementation of the regulatory framework in Section 10.3.

We also discuss how the proposed framework could be subsequently extended to encompass suitable licence-exempt devices in a subsequent (optional) second phase in Section 10.4.

10.1 Current regulatory framework

The use of radio communications equipment is authorised under the Wireless Telegraphy Act 2006 which specifies that radio equipment cannot be installed or used in the UK except under the authority of a licence granted by Ofcom, or otherwise exempted by regulations made by Ofcom.

Under Regulation 8B of the Wireless Telegraphy Act, Ofcom is not empowered to grant exclusive licences for the use of spectrum throughout the UK unless it is necessary to protect safety of life services or alternatively there are other exceptional circumstances (as set out in the Act). By default, therefore, spectrum licensees are potentially required to share spectrum with other licensees.

It is a condition of a licence/exemption regulation granted/prepared by Ofcom that the equipment must meet the minimum requirements set out in the UK Interface Requirement that applies to the stated frequency band and stated equipment type. An Interface Requirement typically includes key technical parameters such as maximum power transmission limits and often refers to a specific equipment specification with which the equipment must be compliant.

Under the Radio Equipment Regulations[62], manufacturers of radio communications equipment are required to undertake a conformity assessment of all radio equipment to confirm it is operating in compliance with the relevant standard. The conformity assessment can be undertaken by the manufacturers themselves or alternatively using a UK Market Conformity Assessment Body (UKMCAB). Equipment is then marked as UKCA (UK Conformity Assessed) which has replaced the CE (Conformité Européenne) market following the UK's exit from the European Union.

In the remainder of this section, we summarise how the current framework for awarding LALs and SALs operates as well as detailing how the TV White Spaces framework previously operated, since this was the previous implementation of a dynamic shared access framework in the UK, albeit for licence-exempt devices rather than licensed devices.

10.1.1 LAL and SAL regulatory framework

Local Access Licences and Shared Access Licences are issued by Ofcom under its licensing powers from the Wireless Telegraphy Act. The LALs and SALs are governed by:

---

[62] UK Government, 'Statutory Instrument 2017 No. 1206: TELECOMMUNICATIONS: The Radio Equipment Regulations 2017', published 4 December 2017 as amended by UK Government, 'The Product Safety and Metrology etc. (Amendment etc.) (EU Exit) Regulations 2019' and by UK Government, 'The Product Safety and Metrology etc. (Amendment etc.) (Amendment to Extent and Meaning of Market) (EU Exit) Regulations 2020'.

- Ofcom's local licensing statement of 2019[63] which made spectrum in the 3.8-4.2GHz, 1800MHz, 2300MHz and 26GHz bands available through shared access licences as well as providing access to spectrum which is licensed to the mobile operators though the local access licensing process.
- Updated rules for use of the shared access licence bands[64] published in July 2024.
- Further updated rules for the shared access licence bands[65] published in December 2024.
- Local Access Licence Guidance document[66].
- Shared Access Licence Guidance document[67].
- The Interface Requirement for each frequency band.

In relation to the LALs, the mobile operators and local access licensees are required to cooperate with each other to ensure no harmful interference arises. LALs have been historically issued on the basis that the mobile operator has no plans to make use of the spectrum in the specified geographic area in the foreseeable future (LALs are for a default duration of three years – though shorter and longer periods can also be agreed/negotiated). Effectively the mobile operator has priority over use of the spectrum.

In relation to the SALs, licences are issued where spectrum is available in the specified area. A 'first come, first served' approach has been used – such that newer licences are not awarded if they would cause interference to an existing SAL licensee – or other areas in which the spectrum is being used for other purposes.

10.1.2 TV white space regulatory framework

Access to TV White Space (TVWS) spectrum through the use of a database approach was implemented in 2015[68]. This allowed licence-exempt use of the spectrum and was the first implementation of a database-driven dynamic spectrum assignment system in the UK.

A licence-exemption regulation[69] was issued in December 2015 which allowed White Space Devices to be licence-exempt provided they were complaint with the usage conditions specified in the regulation which stated that the devices can transmit only after requesting and receiving parameters from a database. Specifically, a 'master' device has to obtain a spectrum assignment from an authorised TV white spaces database and a 'slave' device is required to communicate as authorised by a 'master' device.

[63] Ofcom, 'Enabling wireless innovation through local licensing: Shared access to spectrum supporting mobile technology: Statement', 25 July 2019.

[64] Ofcom, 'Enabling Access to Shared Spectrum: Statement and further consultation on enhancing the Shared Access Licence Framework', 24 July 2024.

[65] Ofcom, 'Enabling Access to Shared Spectrum: Statement on further measures to support licensees and enable new use cases', 2 December 2024.

[66] Ofcom, 'Local Access Licence: Guidance document'. July 2019.

[67] Ofcom, 'Shared Access Licence: Guidance document', 14 January 2025.

[68] Ofcom, 'Implementing TV White Spaces: Statement', 12 February 2015.

[69] UK Statutory Instruments 2015 No. 2066, 'Wireless Telegraphy (White Space Devices) (Exemption) Regulations 2015', 18 December 2015.

The authorised databases were specified in Schedule 1 of the Regulations and for a database provider to be added to this schedule, they were required to pass a 'Qualification Assessment' as detailed in the White Space Database Provider (WSDP) contract between Ofcom and the database provider.

In February 2024 Ofcom announced that the TVWS service would no longer be available as the last remaining database provider had stopped offering service. Ofcom indicated that it would revoke the licence-exemption regulation pertaining to TVWS.

Nonetheless, there are many aspects of the TVWS framework that can be reused/form the basis of a new DSA framework. This includes some of the principles established in the contract between Ofcom and the WSDPs including:

- Provisions for the WSDPs to provide an administrator interface to Ofcom in order to support interference investigation and mitigation.
- The passage of confidentially sensitive information (e.g. assignments of the existing users of the bands) between Ofcom and the White Space databases under an NDA.

Another example is the developed approach to licensing manually configurable devices[70][71] which could also be useful for short-term assignments in the SAL frequency bands.

10.2 Implementation of DLALs and DSALs

Operational model

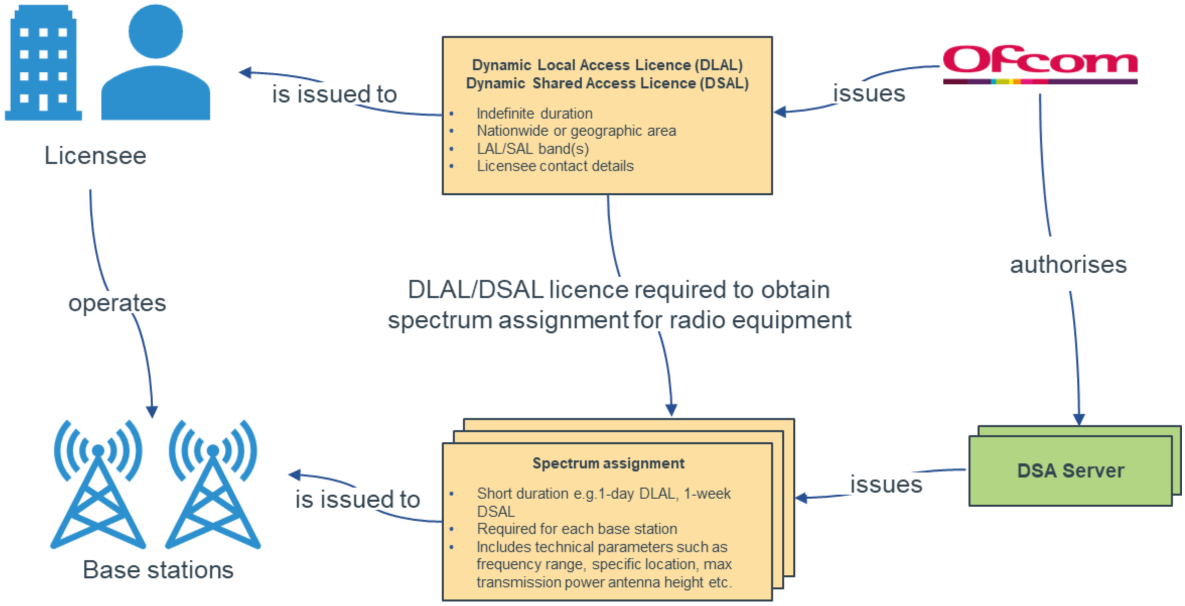
As discussed in Section 2, it is intended that an organisation wishing to make use of dynamically assigned spectrum in the LAL or SAL spectrum bands would require an administrative licence (either DLAL or DSAL) from Ofcom as a precursor to obtaining specific spectrum assignments from a DSA Server.

As shown in Figure 10-1 below, the DLAL or DSAL licence would provide authorisation to operate either nationwide or in a specific area. One of the benefits of this licensing process is that Ofcom will hold full details of the licensees (including contact details) in the event of any issues.

[70] Ofcom, 'Licensing manually configurable white space devices: Statement', 25 September 2015, accessed at https://www.ofcom.org.uk/siteassets/resources/documents/consultations/7877-manually-configurable-wsds/statement/licensing_manually_configurable_white_space_devices.pdf?v=335106

[71] See Ofcom, 'Licence for manually configurable white space devices', accessed at https://www.ofcom.org.uk/siteassets/resources/documents/manage-your-licence/tvws/mcwsd-licence_example.pdf?v=335410

Figure 10-1: Overview of dynamic access licensing model



Specific spectrum assignments for radio equipment would then be made by the DSA Server communicating with the radio equipment[72] and authorising the transmission parameters for use (e.g. frequency range(s), power levels, timing synchronisation details etc). The DSA Server would make assignments such that they do not result in users interfering with each other and also prioritising incumbent use, where applicable.

This mechanism for licensing and spectrum assignment would essentially be the same for LALs and SALs. The main difference between the two types of licence are the frequency bands concerned and the nature of incumbent use (and hence protection requirements).

Legal implementation

We believe that the updated licensing framework can be implemented under Ofcom's existing powers under the Wireless Telegraphy Act. We would expect that Ofcom would need to prepare a detailed consultation document, undertake the consultation including a detailed review of responses and then prepare a final Statement. This would then lead to the updating of guidance notes for the local access and shared access licensing regimes as well as any updates to the Interface Requirements for each relevant frequency band.

The DSAL/DLAL licences issued by Ofcom:

- could be nationwide or cover a specific geographic area.
- could cover all frequency bands available to DLAL or DSAL users or be specific to individual band(s).
- should require equipment e.g. medium or high-power base station) operating in the band to only be authorised to transmit if it has received a spectrum assignment from one of the designated DSA

[72] It may also be that a simpler approach could be adopted for DSALs whereby the transmitting devices are not required to directly communicate* with the DSA Server - See, for example, proposals for an "automated-to-the-engineer" approach as discussed in 5G New Thinking, 'Response to Ofcom consultation "Supporting the UK's wireless future: Our spectrum management strategy for the 2020s"', 26 February 2021.

Servers – and transmissions would be required to be in accordance with the parameters provided by the DSA Server (e.g. maximum transmit power levels).

It is envisaged that there could be multiple DSA Servers, provided by industry, all of which would need to be synchronised. The DSA Servers would be designated by Ofcom through a contracting process – perhaps similar to that used for TVWS or as recently proposed by Ofcom for AFC operators in the 6GHz band[73].

It is anticipated that the servers would use interference protection rules published by and/or agreed with Ofcom.

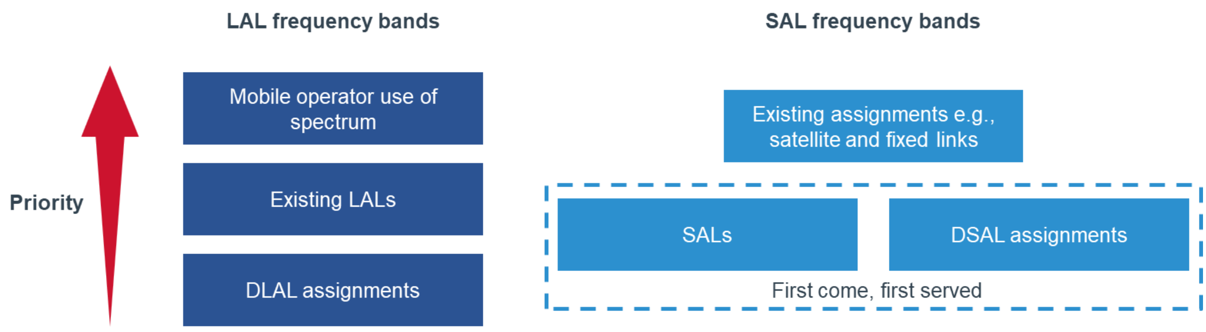
Ideally the mobile operators would provide information Ofcom on their base station sites/areas of use of the spectrum which could then be passed on to the DSA Servers and updated as changes are made to the mobile networks. We understand that Ofcom has existing powers to require such information from the mobile operators as part of Ofcom's licensing conditions. We acknowledge the commercial sensitivity of this information and note that similarly sensitive information was successfully shared with TVWS database providers under NDA for similar purposes.

Prioritisation of licensees

As shown in Figure 10-2 below, we propose that:

- Mobile operators in the LAL bands will continue to have priority over the LAL and DLAL licensees in the band. The LALs will also have priority over the DLAL assignments. If the national mobile operator begins overlapping usage of the assigned spectrum, then DLAL users will be required to change frequencies (or cease transmission) to prevent interference.
- In SAL spectrum bands, pre-existing assignments made to existing users of the spectrum (e.g. satellite, fixed links) would be protected from harmful interference and allowed to cause harmful interference to new users. This protection does not apply to any new assignments to these users – or changes to their current assignments. Existing SAL assignments and new DSAL assignments would be treated/made on a first-come, first served basis.
- Equipment operating under DLAL/DSAL licences would only be assigned spectrum by the database if it does not cause harmful interference to, or receive harmful interference from, the existing LAL/SAL licences' assignments.

Figure 10-2: Prioritisation of licensees



[73] See Ofcom, 'Expanding access to the 6 GHz band for mobile and Wi-Fi services: Proposals for AFC in Lower 6 GHz and mobile / Wi-Fi sharing in Upper 6 GHz: Consultation', 13 February 2025.

In relation to the LAL and SAL licences:

- We would expect existing LALs to continue to the end of their current licences (typically 3 years) and licensees will then be able to apply for a new 3-year period.
- Other users requiring a 3-year licence period could continue to apply for LALs under the current process.
- Existing SALs would continue indefinitely as per the existing licensing conditions.

Scope, duration and fees for licences and assignments

As indicated above, the DLAL/DSAL licences could be nationwide or cover a specific geographic area(s) and would authorise multiple pieces of equipment to be used in these geographic areas. We envisage that the licence could last indefinitely and a one-off administrative fee could be paid for each licence (set on a cost-recovery basis by Ofcom).

The dynamic spectrum assignments would be made to an individual transmitting station (e.g. mobile base station) at a specific location. The spectrum assignment duration could be 24 hours. Providers of DSA Servers will be free to charge a reasonable fee for spectrum assignments, and DLAL/DSAL licensees will be free to choose which DSA Server(s) to use. If necessary, Ofcom could retain the powers to intervene in the pricing in the event of market dominance.

This is summarised in Figure 10-3 below.

Figure 10-3: Scope, duration and fees for DLAL/DSAL licences and spectrum assignments

	DLAL / DSAL licence	Dynamic spectrum assignment
Scope	Licences could be either **national** or **sub-national** areas Would cover multiple pieces of equipment/allow multiple assignments	Spectrum assigned for an individual device at a **specific geo-location**
Duration	Licences could last indefinitely (unless revoked)	Dynamic spectrum assignment period would be specified as part of the DLAL/DSAL rules (e.g. 24 hours)
Fees	One-time small administrative fee paid to Ofcom per DLAL or DSAL licence (set on a cost-recovery basis)	Fee to be determined by DSA server providers

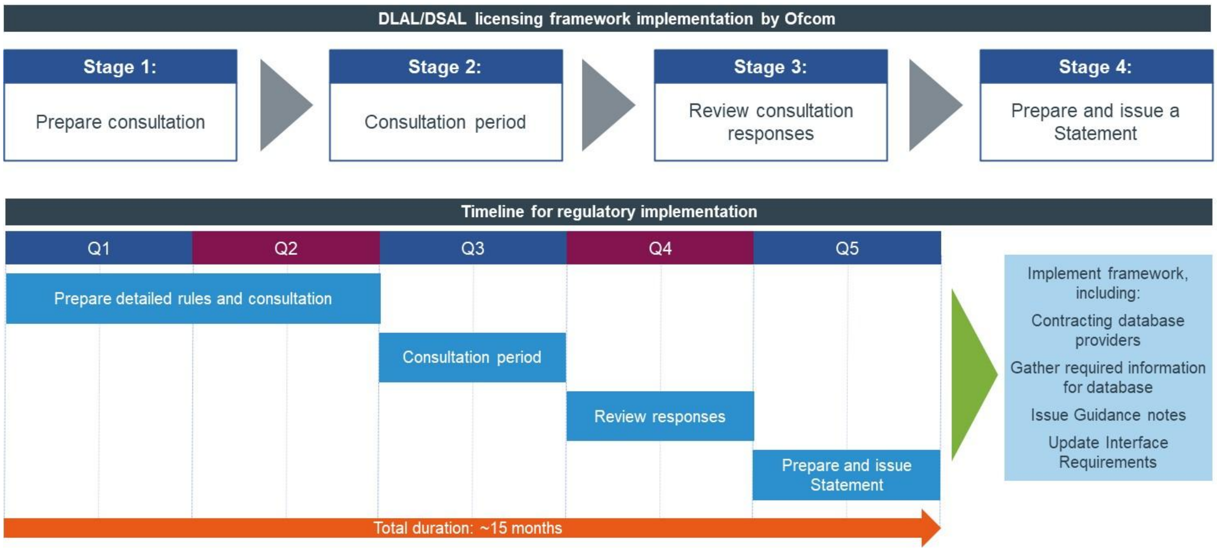
10.3 Roadmap for implementation

Figure 10-4 comprises an illustrative timeline for the regulatory implementation which involves the following key stages:

- Stage 1: Preparation of detailed rules/regulatory framework and consultation document (~6 months)
- Stage 2: Consultation period (~3 months)
- Stage 3: Review of consultation responses and update regulatory framework (~3 months)
- Stage 4: Prepare and issue Statement (~ 3 months).

This would amount to a total duration of around 18 months. In parallel with the regulatory implementation, further prototyping of the proposed solution could continue, building on the development work undertaken in Work Packages 1 and 2 of this sandbox.

Figure 10-4: Indicative timeline for regulatory implementation



Following the implementation of the regulatory environment, the detailed implementation could proceed including contracting database providers (who we envisage would have commenced R&D work during Stages 3 and 4 of the regulatory process) and finalising all the appropriate regulations and guidance notes.

10.4 Optional Phase 2: Extension for licence exempt use

There could be a further Phase 2 of implementation where certain equipment could be authorised to operate on a licence-exempt basis (for example, similar to the General Authorised Access regime for CBRS in the USA).

Operational model

This could be, for example, to allow low power radio equipment that is certified as meeting certain specific requirements (for example for the radio equipment to be able to provide an accurate geolocation automatically) to operate in the LAL and SAL spectrum bands without requiring a DLAL or DSAL licence – but it would require a spectrum assignment from a DSA Server.

Under such a scenario, other equipment (not meeting licence-exempt criteria) would continue to be licensed under the DLAL/DSAL licensing regime (so Ofcom continues to hold details in its licensing database of these users).

Legal implementation

The implementation of licence-exempt access to DLAL and DSAL spectrum could draw upon the framework previously used for TVWS device. Here a DLAL/DSAL-specific licence exemption regulation would be required to be issued to cover such low-power uses (i.e. to make the equipment exempt from requiring a licence under the Wireless Telegraphy Act).

The regulation would:

- Define the required parameters / properties of devices to be eligible for licence exemption.
- Identify databases / database providers which may assign access to prescribed frequency bands – we expect this would be likely to be the same list as for licensed DLAL/DSAL use.
- Define the characteristics of devices to be used.
- Define the information (including operating parameters) to be transferred between devices and database.

11. Conclusions

Our economic assessment has estimated that around GBP80 million of net benefit (net present value over the period 2025-2036, discounted to 2024-25) could be realised for the UK economy through the implementation of DSA in the LAL and SAL frequency bands.

Taking account of the uncertainties over key assumptions used in our estimations of the benefits of individual use cases, we note that the overall net benefit could range from around GBP35 million to GBP140 million (net present value 2025-2036, in 2024/2025 terms).

Furthermore, this is a quantitative estimate of the benefits based on assessing five potential use cases. There could be other use cases that we have not considered – and, furthermore, those five use cases have wider benefits that are not quantifiable (for example improved television viewer experience, promotion of lower tier sports).

We therefore recommend DSIT and Ofcom proceed with introducing DSA to the LAL and SAL bands. We believe that this can be undertaken using Ofcom's existing powers under the Wireless Telegraphy Act 2006 and an 18 month process would be required to develop, consult on and finalise new regulations.

DSA is very much the future of spectrum management, and it is important for the UK to take a leading position in this area. We are pleased that Ofcom has recently published proposals for introducing DSA in the 6GHz band[74] and we believe that there will be synergies between this and enabling DSA in the LAL and SAL bands in terms of development costs, but more than this it will place the UK in a leading position in terms of early adoption of DSA and the wider economic benefits to the UK economy that arise from this. Over time the benefits of introducing DSA across multiple spectrum bands could amount to as much as GBP2.5 billion per annum (based on a conservative assumption that introducing DSA would yield around a 5% increase in the economic value realised from spectrum in the UK).

[74] See Ofcom, 'Expanding access to the 6 GHz band for mobile and Wi-Fi services: Proposals for AFC in Lower 6 GHz and mobile / Wi-Fi sharing in Upper 6 GHz: Consultation', 13 February 2025.

Annex A Review of economic benefits assessment studies

To assess the economic benefits of providing high-speed mobile and broadband connectivity to users located in less populated areas, we undertook a detailed assessment of existing studies. From these, we identified four studies that have greatest relevance to the use cases being considered in our economic evaluation. We summarise the approaches used and findings from each of these studies in the sections below (Annex A.1 for studies covering the benefits of improved mobile coverage and Annex A.2 for studies on the benefits of improved fixed broadband connectivity).

A.1 Studies assessing the economic benefits of improved mobile coverage

Analysing community benefits of mobile investment (FarrPoint)

In June 2024, FarrPoint published a study[75] commissioned by EE on the economic impact of four EE mobile masts built through the SRN programme across England, Wales, Scotland, and Northern Ireland. The primary objective of this research was to understand and evaluate the magnitude of the economic and social benefits that mobile connectivity can bring to different types of rural communities.

FarrPoint's report focuses on quantifying three sources of benefits: the initial construction impact (for example, through the use of local suppliers and contractors), the general economic Gross Value Added (GVA) impact, and the social wellbeing impact. The report also discusses some additional qualitative benefits that could not be quantified, as well as the build, operation, and maintenance costs (provided by EE).

We list some of the key assumptions from FarrPoint's analysis:

- The initial construction impact is calculated as 25%-50% of the investment in infrastructure (it is assumed that this amount will be spend on local construction and installation of infrastructure), plus multiplier effects to account for further economic activity.
- GVA is assumed to grow by 0.5% per annum in areas affected by the improved connectivity.
- Positive adjustments are made for sites that are near tourist spots – it is assumed that each visitor spends 15 minutes online.
- It is assumed that improved connectivity in 'not-spots' is associated with an annual wellbeing uplift equivalent to GBP93.78 per person, including an inflation adjustment and a rural uplift of 10% – this assumption is based on a DCMS consultation outcome from 2022 on the benefits of superfast broadband[76].

[75] FarrPoint, 'Rural 4G connectivity: Analysing the community benefits of mobile investments', June 2024, https://www.farrpoint.com/uploads/store/mediaupload/1501/file/Rural_Connectivity_Study_FarrPoint_EE_June2024.pdf

[76] DCMS consultation outcome, 'Call for Evidence: Improving connectivity for Very Hard to Reach premises', May 2022, https://www.gov.uk/government/consultations/improving-broadband-for-very-hard-to-reach-premises/call-for-evidence-improving-connectivity-for-very-hard-to-reach-premises

- Number of people impacted by improved connectivity is assumed to be 85%-95% of the population living within the coverage area of the site. It is also assumed that only 35%-43% of these will become EE customers, so the benefits are applied to 30%-41% of the population covered by the site.
- Starting from the third year since the site has been built, the annual estimated impact is reduced by 13.2% per annum, in line with the results of the UK Government's Superfast Broadband Programme Evaluation.
- An annual discount rate of 3.5% is assumed, and the benefits and costs are calculated over 15 years.

The results of the study are shown in Figure A-1 below. Please note that the population within the coverage area of the site in Mallaig has been estimated by Aetha rather than taken from the FarrPoint report. The size of the total benefits per person across 15 years ranges from GBP386 to GBP775. The variance stems from a few factors:

- The initial construction benefit is the same across the four sites, but the sites' population coverage ranges from 580 to 13 000.
- General economy benefits per person are higher in zones with a higher local initial Gross Value Added.
- Social wellbeing benefits per person are higher in areas with low fixed broadband penetration and in areas with higher levels of deprivation.

Figure A-1: Benefits from improved connectivity [Source: Aetha analysis based on FarrPoint report]

	Mallaig	Trawsfynydd	Melton Mowbray	Dunseverick
Benefits across 15 years (GBP thousand)				
Initial construction	65 – 129	65 – 129	65 – 129	65 – 129
General economy	504 – 688	145 – 199	3516 – 4828	218 – 292
Social wellbeing	173 – 238	40 – 54	1443 – 1982	71 – 97
Total benefits	742 – 1054	249 – 383	5024 – 6939	353 – 518
Population covered	1360	580	13 000	700
Benefit per pop. (GBP)	546 – 775	429 – 660	386 – 534	504 – 740

Estimating the value of mobile telephony in mobile network not-spots (RAND Europe)

In 2014, RAND Europe published a report[77] commissioned by the UK Department for Environment, Food & Rural Affairs (DEFRA) to estimate the social and economic impacts associated with the elimination of rural 'not-spot' areas for residents and businesses, as well as local visitors.

[77] RAND Europe, 'Estimating the value of mobile telephony in mobile network not-spots', 2014, https://assets.publishing.service.gov.uk/media/5a80d25d40f0b62305b8d56a/Mobile_network_not_spots_final_report.pdf

The core of RAND Europe's study is a survey conducted with people living in rural 'not-spots', collecting data on the characteristics and communication practices of more than 700 respondents, using a stated preference discrete choice experiments (SPDCE) methodology.

One of the outputs from RAND Europe's analysis is an estimate for the willingness to pay for mobile services for people living in rural 'not-spots', in addition to the monthly price for a mobile subscription. This data can be used as an estimate for the consumer surplus from improved connectivity in these areas.

The results of RAND Europe's analysis can be seen in Figure A-2 (local residents), Figure A-3 (local visitors), and Figure A-4 (businesses). In each case, the figures show the additional willingness to pay for mobile service depending on a series of factors, such as technology (2G or 3G/4G), signal strength (poor signal quality, better signal quality), or the distance to travel required to exit the 'not-spot' and receive mobile connectivity. The conclusion of the study shows that people living in 'not-spots' are willing to pay significantly above the price of a mobile subscription for mobile connectivity. For a good quality 3G/4G services, on average, 'not-spot' residents were willing to pay an additional GBP24.7 (+/- GBP6.5) per month, local visitors GBP22.0 (+/- GBP 8.3) per month, and local businesses GBP33.2 (+/- GBP24.6) per month.

Figure A-2: Willingness to pay for residents in not-spot areas for mobile phone service (GBP/month) [Source: RAND Europe)

	Not-spot residents			
	2G		3G/4G	
Distance to travel (miles)	Same signal quality	Better signal quality	Same signal quality	Better signal quality
Outside				
– Age < 65 years	6.00	17.30	7.30	18.70
– Age > 65 years	0.00	11.40	1.40	12.70
0.25	10.70	22.00	12.00	23.40
0.5	11.20	22.50	12.50	23.90
1	12.20	23.50	13.50	24.90
2	14.20	25.50	15.50	26.90
5	20.10	31.50	21.50	32.90
Average valuations				
WTP (avg distance = 0.92)	12.00	23.40	13.40	24.70
90% Confidence Interval	+/-4.10	+/-5.10	+/-3.00	+/-6.50

Figure A-3: Willingness to pay for local visitors to not-spots for mobile phone service (GBP/month) [Source: RAND Europe)

	Not-spot local visitors			
	2G		3G (Age <45)	
Distance to travel (miles)	**Same signal quality**	**Better signal quality**	**Same signal quality**	**Better signal quality**
With signal/outside (reference)				
0.25	4.90	13.60	11.80	20.50
0.5	5.30	14.00	12.20	20.90
1	6.10	14.80	13.00	21.70
2	7.70	16.50	14.60	23.40
5	12.60	21.40	19.50	28.30
Average values				
WTP (avg distance =1.16 miles)	6.30	15.10	13.20	22.00
90% Confidence Interval	+/-3.80	+/-4.10	+/-5.10	+/-8.30

Figure A-4: Willingness to pay for businesses in not-spots for mobile phone service (GBP/month)

	Not-spot businesses			
	2G		3G/4G	
Distance to travel (miles)	**Same signal quality**	**Better signal quality**	**Same signal quality**	**Better signal quality**
With signal/outside (reference)				
0.25	17.30	20.90	26.00	29.60
0.5	18.60	22.20	27.30	30.90
1	21.20	24.80	29.90	33.50
2	26.50	30.20	35.20	38.80
5	42.40	46.00	51.10	54.70
Average values				
WTP (avg distance = 0.94 miles)	21.00	24.50	29.60	33.20
90% Confidence Interval	+/-11.50	+/-14.00	+/-16.60	+/-24.60

A.2 Studies assessing the economic benefits of high-speed broadband

Evaluation of the Superfast Broadband Programme – State aid evaluation: Main Report (Ipsos)

In February 2023, Ipsos UK completed a study[78] for the Building Digital UK (BDUK) directorate of the Department for Digital, Culture, Media and Sport (DCMS), to undertake a State aid evaluation of the UK Superfast Broadband Programme. This report focuses on Phase 3 of the Superfast Broadband Programme, covering contracts awarded from 2016 totalling over GBP1 billion. The aim of the scheme was to provide superfast broadband to areas where availability remained under 95%.

The report completed an in-depth cost and benefit analysis identifying the following as the main drivers of benefits:

- Local employment impacts: there was an increase in employment in areas benefiting from the programme of 0.88%.
- Turnover: the subsidised coverage from this programme increased turnover of local firms by 1.6%, this corresponded to a turnover gain of GBP63 per premise upgraded. This corresponded to a GVA of GBP20 per annum.
- Number of firms: there was an increase in the number of firms in the areas benefiting from coverage of 0.5%.
- Turnover per worker: turnover per worker rose 0.42% overall in areas benefitting from coverage (0.17% in existing firms).
- Wages: hourly earnings rose 0.6% to 0.8% in areas benefiting from coverage.
- Unemployment: unemployment claimants fell by 34.3 for every 10 000 premises upgraded. It was calculated that 29% of these claimants would be taken out of long-term employment and therefore the number of long-term claimants decreased by 9.8 per 10 000 premises upgraded.
- Increase in house prices for connected properties: the study suggested that upgraded premises rose in price between GBP1900 and GBP4900 – based on hedonic pricing approaches, this was interpreted as a measure of the average gain in social welfare associated with access to superfast and gigabit capable broadband networks on the basis that the maximum households are willing to pay should reflect the marginal gain in wellbeing derived from access to the technology.

The role of wireless networks in enhancing digital connectivity in the UK (Intelligens Consulting)

In September 2024, Intelligens Consulting completed a study[79] for the UK Wireless Internet Service Providers Association (UKWISPA), investigating the case for wireless technologies to support the delivery of the UK Government's 2030 Gigabit ambitions. The report highlights how the use of wireless technologies can bring forward access to faster broadband speeds in both rural and urban areas.

---

[78] Ipsos, 'Evaluation of the superfast broadband programme State aid evaluation', February 2023, https://assets.publishing.service.gov.uk/media/64f06eb96bc96d00104ed3a0/21-087286-01_Superfast_State_Aid_Evaluation_-_Main_State_Aid_Report_-_FINAL_VERSION_RedactedV2.pdf

[79] Intelligens Consulting, 'The role of wireless networks in enhancing digital connectivity in the UK', 9 September 2024, https://irp.cdn-website.com/e14ecd1c/files/uploaded/20240909_Intelligens_Consulting_Report_for_UKWISPA.pdf

Further, the report claims that these connections will be at a lower cost than the use of fixed lines. The report outlines four areas of economic benefit due to the rollout of FWA:

- Accelerated deployment of broadband services to rural areas.
- Extended deployment of broadband services to rural areas.
- Reducing the cost of broadband rollout by using wireless access as a complement to fibre.
- Reducing the cost of broadband rollout by enhancing competition.

Some key assumptions that are made in this report are:

- 60% of premises that can take up superfast broadband will do so.
- Users on average will be willing to spend GBP35 a month for access to these services
  - This compares to Starlink subscriptions which are set at GBP75 a month.
- The cost to bring a fibre line is GBP30 per metre with distances between properties of 1km in rural locations suggesting GBP30 000 to connect a property in these areas.
- The initial investment required to set up an FWA network is GBP20 000 and includes Mast, power setup, backhaul radio and AP radios.
  - Up to 1000 customers can be covered using this setup assuming line of site to the antenna giving a total cost per premises passed of GBP20.
- The cost to activate a customer is then GBP500-700.

The main result of this study is that there will be a reduction of total costs in connecting hard-to-reach areas of GBP29 million a year due to the savings compared to satellite. However, this assumes that 60% of all 100 000 hard-to-reach premises will be able to gain access to FWA via a local provider. We do not believe that providers will offer services to all hard-to-reach premises due to prohibitive deployment costs and therefore this GBP29 million a year is probably over-stating the total potential benefits gained from cost savings to the consumer.

Annex B Additional use case: Mobile operators using SAL spectrum

B.1 Introduction

National mobile operators may benefit from temporary access to additional spectrum for surge capacity, allowing them to serve increased traffic for example at events. Public mobile networks are generally designed to serve the traffic that is typical year-round in an event location, rather than for the peak during the event. For this reason, public mobile networks often become highly congested at events.

Shared access spectrum in the 3.8GHz to 4.2GHz range is generally supported by 5G capable mobile devices, and this spectrum is similar to the mobile operators' 5G spectrum in the 3.4-3.8GHz range. Dynamic access to this spectrum would allow thee mobile operators to deploy temporary base stations at events using this spectrum to cost-effectively serve the additional traffic generated by event attendees. The SAL spectrum could be used in addition to the mobile operators' existing spectrum holdings.

B.2 Methodology for quantification of benefits and costs

Our overall approach is to assess the benefits arising from mobile operators having temporary access to shared access licence spectrum as a result of the introduction of dynamic access local access licences. From this we deduct the costs associated with the national mobile operators deploying radios to surge events, resulting in an overall estimation of the net benefit, as shown in Figure B-1 below.

Figure B-1: High-level methodology for quantification of benefits and costs for mobile operators using SALs for surge capacity

(Increase in total traffic served) × (Benefit per unit traffic) – (Cost of deploying additional radios)

Our approach is summarised in Figure B-2 below. This involved estimating the:

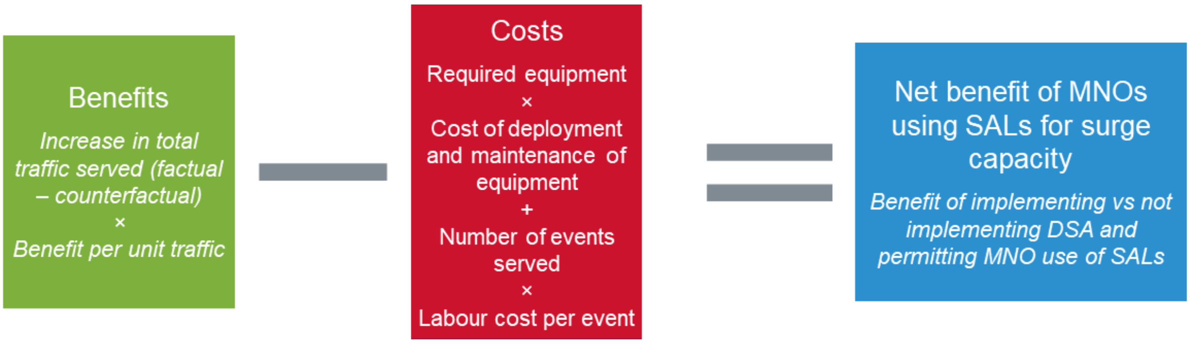
- **Increase in total traffic served:** We first estimated the number of events that are large enough to justify a short-term deployment by mobile operators to serve surge traffic. We then estimated the traffic that can be served by each deployment, based on the available spectrum. We assume that all the available capacity will be consumed by event attendees.

- **Benefit per unit traffic:** We assume that the value of the additional incremental traffic served by this use case is the same as the average value of traffic to mobile users.

- **Cost of deploying radios at events:** We estimated the cost of implementation from the cost of the radios and labour required to serve the events.

The overall net benefit of this use case is calculated from subtracting the costs of deploying radios at events from the estimate of benefits.

Figure B-2: Methodology for calculating net benefit for additional capacity for national mobile operators using SALs for surge capacity



As described in Section B.1 above, the main benefit of this use case is mobile users being able to consume greater traffic at events.

The main cost is from national mobile operators deploying additional RAN equipment at events.

B.2.1 Number of events

The first input to calculating the benefits and costs of this use case is the number of events which can be served.

In Section 7.2.1, we detailed our approach to analysing festivals data published by the Events Industry Forum (EIF), which included selecting events with between 500 and 10 000 attendees. For this use case, we consider events with between 20 000 and 100 000 attendees. These events are large enough that attendees should be able to consume all the additional capacity provided by the mobile operators under this use case. Events with greater than 100 000 attendees will mostly already have additional capacity provision by the mobile operators.

Under this assumption, 127 events are of an appropriate size for this use case, and these have a total attendance of 5.2 million people.

Whilst events other than festivals are also likely to benefit from this use case, limited data is available on their attendance. We assume that the festivals are likely to generally be high-traffic events. We assume that the distribution of other outdoor events may have fewer high attendance events, and it is common for attendees to use mobile data to upload images and videos during performances. For these reasons, we assume that the number of additional non-festival events relevant to this use case is the same as the number of festivals (127), lower than our assumption in Section 7.2.1 for Use case 4.

B.2.2 Benefit per event

To estimate the benefit of this use case, we calculated an estimate of the increase in total traffic that can served at surge events. We can then estimate the value of this additional served traffic to mobile users.

B.2.2.1 Increase in total traffic served

To estimate the increase in total traffic, we consider the number of sites that would be deployed by mobile operators at events, and the amount of traffic that each site would serve, based on the available spectrum and typical spectral efficiency.

We assume that all the mobile operators would deploy on average a single temporary site at each of the events identified in Section B.2.1. In locations without existing users, there is sufficient shared access spectrum available for each operator to deploy a full 100MHz carrier of 3.8-4.2GHz spectrum. We assume a conservative spectral efficiency of 3.5bps/Hz for the radios utilising this spectrum and that the sites deployed will have three sectors.

Assuming an average surge event duration of 3 hours, a total of 4253GB of additional traffic may be served by the mobile operators' sites at each event. Across all 127 events, a total of ~1PB of additional traffic may be served per year.

We have considered sensitivities on the number of sites that mobile operators would deploy on average to events (two vs one in the base case) and the number of relevant events for this use case (127 vs 254 in the base case).

B.2.2.2 Value of additional traffic served

To estimate the value of the additional traffic calculated in Section B.2.2.1, we assume that the value of each GB of this traffic is the same as the average price paid for a GB of traffic to mobile users in the UK. We therefore first estimate the price per unit traffic in the UK.

Ofcom's Q3 2024 market data update[55] reports the quarterly total mobile traffic as ~2.6PB (~10.5PB per year). The additional traffic calculated in Section B.2.2.1 is therefore ~0.01% of total yearly traffic. We assume that the size of the relative increase to total traffic will remain constant across the modelling period.

Ofcom's report also provides the average UK monthly ARPU as GBP13.37 and the total number of UK mobile subscribers as ~89.5 million. By multiplying the number of subscribers and the average ARPU, we generated an estimate of total mobile revenue (~GBP14.4 billion per year).

The total value per GB of traffic can be calculated as ~GBP1.4 by dividing total mobile operator revenue by total traffic. By multiplying this value by the additional traffic due to this use case, we calculate the benefit of this use case as ~GBP1.5 million in 2027. We assume that mobile ARPUs will increase with inflation over the modelling period.

B.2.3 Costs of providing connectivity to events

The costs of providing connectivity to events result from both the equipment required and the labour cost of deploying it.

We estimate that to ensure that simultaneous events could all be served, each operator would require a total of 20 deployable mobile sites (60 in total) to serve the 254 events in the base case. We scaled this estimate linearly with the number of events and sites per event in our sensitivity analysis.

Equipment maintenance is a recurring annual expense for each radio, and labour costs are incurred for each event. We scale the labour and power costs per event with the number of sites per event in our sensitivity analysis.

Figure B-3 below details our estimates for the costs associated with deploying radios for this use case, based on our experience of modelling mobile networks.

Figure B-3: Cost of equipment, maintenance and labour for mobile equipment using SAL spectrum operated by a mobile operator for surge capacity at events

Cost item	Cost as of 2025 (GBP)	Annual price trend
Initial deployment costs		
Initial deployment cost - radio equipment, civils and ancillaries	20 000	0%
Recurring costs		
Maintenance (per radio, per year)	1000	Inflation
Labour and power (per event)	1000	Inflation

B.3 Results

The overall benefits from implementing DSA for mobile operators to have access to shared access spectrum for surge capacity are presented in Figure B-4 below.

Figure B-4: Summary of benefits and costs from allowing national mobile operators to use shared access spectrum for surge capacity via dynamic sharing of spectrum (2025-2036)

Source of value/cost	Total value 2025-2036 (GBP million)	Net present value 2025-2036 (GBP million)
Productivity benefit	16.9	13.1
Costs	(4.8)	(3.9)
Total	**12.1**	**9.2**

These results show that there is a net benefit of around GBP9 million in net present value terms over the period 2025-2036. The net present value is as of 2024/2025.

As discussed above, we also undertook sensitivities assuming fewer events or a greater number of sites per event. The outcome of this analysis is provided in Figure B-5 below and the base case is highlighted. It can be seen that the overall net benefit (2025-2036) lies within the range of between GBP5 to GBP20 million.

Figure B-5: Summary of benefits and costs from allowing national mobile operators to use shared access spectrum for surge capacity via dynamic sharing of spectrum (2025-2036) – under different sensitivities

Events served and sites deployed sensitivities	Total value 2025-2036 (GBP million)	Net present value 2025-2036 (GBP million)
50% fewer events (127, 1 site per operator)	6.1	4.6
Base case (254 events, 1 site per operator)	**12.1**	**9.2**
Two sites per operator per event (254 events, 2 sites per operator)	24.2	18.4

Aetha Consulting Limited
24 Hills Road
Cambridge
CB2 1JP
United Kingdom
+44 1223 755575
enquiries@aethaconsulting.com
www.aethaconsulting.com