Agenda for this afternoon's workshop

1:00pm Introduction to the spectrum sandboxes programme (Laura Iglesias, DSIT)

1:10pm QMUL sandbox objectives (Yang Hao, QMUL, James Body, Telet and Alistair Braden, FW)

1:30pm Overview of measurements workstream (James Body, Telet and Alistair Braden, FW)

1:40pm Overview of technical modelling workstream (Yang Hao, QMUL and Alistair Braden, FW)

1:50pm Overview of economic modelling workstream (Razvan Todoran, Aetha)

2:10pm Coffee break

2:40pm Presentation of Real Wireless-led Sandbox (Abhaya Sumanasena, Real Wireless)

3:00pm Panel discussion, including audience Q&A

(William Webb, moderator, Andy Sutton (BT), Charles Turyagyenda (Digital Catapult), Mike Kennett (Freshwave)

4:00pm Workshop wrap-up

4:05pm Post-workshop informal discussions

4:30pm Close

Overview of the Project

QMUL Spectrum Sandbox Stakeholder Workshop

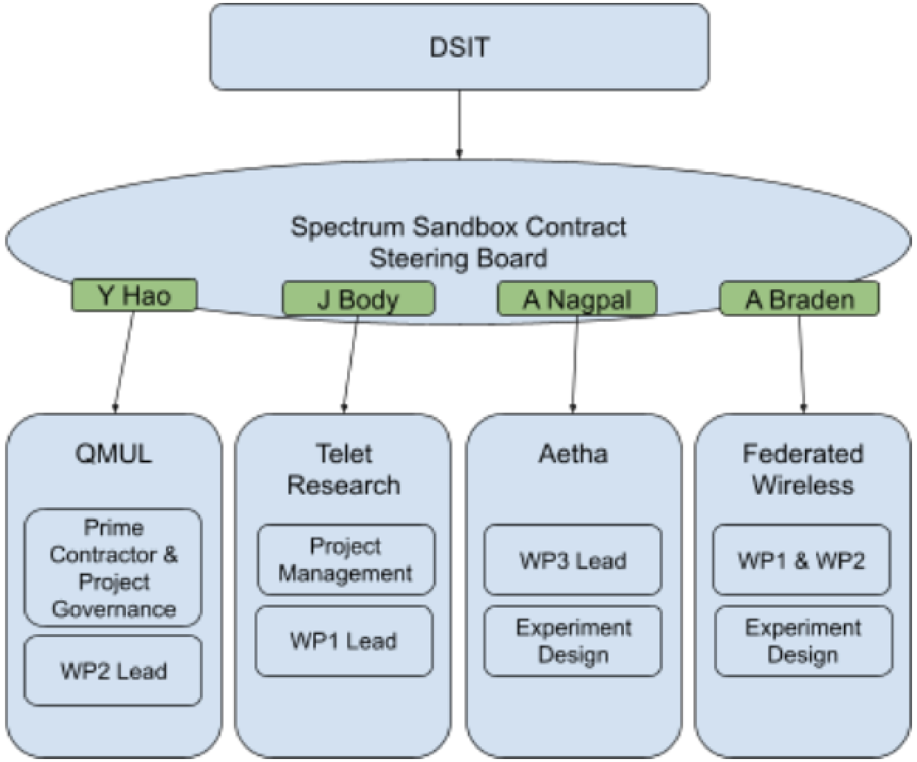
11 June 2024

Introduction to our consortium

Project Steering Board will meet regularly to maintain project direction.

Lead Collaborator appointed within each consortium partner.

Single, Coordinated Project Management & DSIT Liaison Function



QMUL

Telet

Federated Wireless

Aetha

WP1: Set-up sandbox and undertake practical measurements

WP2: Assessment of scalability and impact through simulation and modelling

WP3: Economic assessment and regulatory considerations

Opening the doors of opportunity through distinctive, world-leading, curiosity-driven and applied research

Queen Mary Strategy 2030

Three research campuses across Central and East London

Whitechapel campus
Built around the Royal London Hospital
- Blizard Institute of Cell and Molecular Science
- Institute of Dentistry
- Digital Environment Research Institute

Charterhouse Square campus
Research hub next to Barts Hospital
- Barts Cancer Institute
- William Harvey Research Institute
- Wolfson Institute of Population Health

Mile End campus
The heart of Queen Mary in East London
- School of Electronic Engineering and Computer Science
- School of Engineering and Materials Science
- School of Chemical and Physical Science
- Humanities and Social Sciences

Queen Mary's Nobel prize winners

Sir Ronald Ross: Physiology or Medicine1902, life-cycle of the malarial parasite *Plasmodium*.

Professor The Lord Edgar Adrian: Physiology or Medicine 1932, joint with Sir Charles Sherrington, function of neurons.

Sir Henry Hallett Dale: Physiology or Medicine 1936, chemical transmission of nerve impulses.

Sir John Vane FRS: Physiology or Medicine 1982, prostaglandins.

Professor Joseph Rotblat: Peace 1995, joint with Pugwash Conferences on Science and World Affairs, nuclear abolition and social responsibility of scientists.

Professor Sir Peter Mansfield FRS: Physiology or Medicine 2003, joint with Professor Paul Lauterbur, MRI as a diagnostic technique.

Sir Charles Kao FRS FREng: Physics 2009, transmission of light in fibres in optical communication.

Dr Mario Vargas Llosa: literature, 2010.

Sir Peter Ratcliffe FRS, FMedSci: Physiology or Medicine 2019, joint with William G Kaelin, Jr of Harvard University and Gregg L Semenza of John Hopkins University, hypoxia.

Materials and electromagnetic waves

Time-varying, spatial and spectral agility, MIMO, OAM, waveform engineering, quantum, random

$$\begin{cases} \overline{m} = \overline{e} \times \hat{n} \\ \overline{j} = \hat{n} \times \overline{h} \end{cases}$$

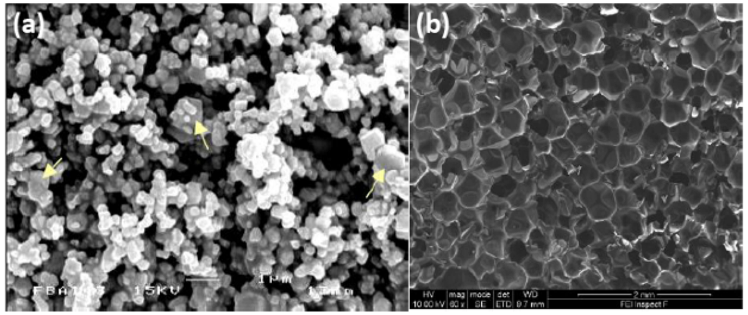


Figure S2 - SEM images of (a) the $BaTiO_3$ powder microstructure, and (b) the controlled-expansion pure polyurethane foam.

$$\begin{cases} \nabla \times \overline{e} = -\mu \dfrac{d\overline{h}}{dt} - \overline{m} \\ \nabla \times \overline{h} = \varepsilon \dfrac{d\overline{e}}{dt} + \sigma\overline{e} + \overline{j} \end{cases}$$

Time-varying, spatial and spectral dispersion, anisotropy, active, nonlinear

ε σ

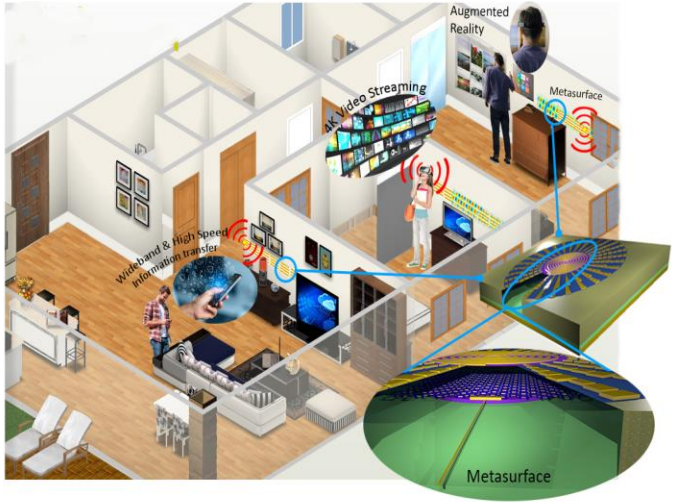
Maxwell Equations

Queen Mary University of London telet fw federated wireless aetha

Pairings Being Targeted

- 1800MHz Band (Band 3) - this is globally the most widely deployed radio band for mobile networks and is frequently used as an “anchor band” in a 4G/LTE network given it provides an optimal blend of both capacity and range and it is therefore supported by virtually every device in the market.
- 3800-4200MHz (Band n77) - this band is one of the main bands available as part of Ofcom’s Shared access regime. It is also a strong proxy for the wider adjacent band (3400-3800MHz) which is the main 5G band used across the world.
- 6425-7125MHz (the ‘upper 6GHz’ band) - in the event that 5G radio equipment supporting this band becomes available (such equipment could be announced at MWC 24), we would look to extend our trials to also consider the sharing possibilities in this band - including between public and private/local 5G networks.

- using dynamic spectrum assignment to enable other shared uses of spectrum including Wi-Fi and Cellular crossover within the upper 6GHz band. This will consider the scope of interference following the identification of the 6425-7125MHz band for mobile use at the World Radiocommunications Conference 2023.
- using real time spectrum usage reporting to enable the management of mobile spectrum in both frequency and time domains in order to achieve much better usage, particularly in High Demand Density areas.
- collection of real time data relating to mobile network coverage areas, network performance and spectrum usage which can be used by Ofcom and other parts of Government.



QMUL Spectrum Sandbox Project Plan

Who are Telet and what do we do?

Andrew Miles
Simon Rockman

- UK's smallest and most agile MNO
- We have:
  - **Developed and deployed a full set of Mobile Network capabilities**
  - **Extensive experience working with DCMS/DSIT (both Lead & Project Member)**
  - **A reputation for innovation and making systems that work**

Our Focus:

- Fixed Wireless Access (FWA)
- Multi Operator Neutral Host (MONeH)
- Private Networks and Applications (5G SA)

Our Solutions Provide Mobile Coverage

- Areas where it is not commercially viable for large MNOs to deploy RAN
- Scenarios where current coverage does exist, but does not meet commercial or functional requirements
- Scenarios where Private RAN offer Public access

Background – who is Telet

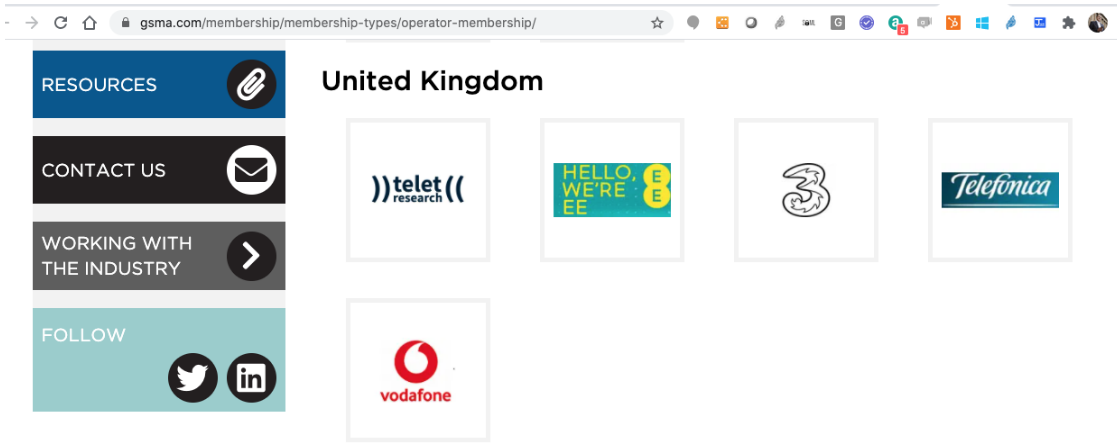
5th UK MOBILE NETWORK OPERATOR

- Founded in 2016 as a community mobile network
- Deployed over 200 cell sites over last four years
- Winner: SCF Excellence in Rural Commercial Deployment award
- Recognised as a full operator member by the GSMA in 2020
- OFCOM mobile numbering and mobile network code

- Have successfully won and delivered a number of DSIT projects including:
  - Liverpool
  - One word – 5 different 5G technologies providing broadband to:
    - Bath, Shropshire, and Cardiff

- Operates the largest private 5G network in Europe in Liverpool:
  - M&S Arena
  - Liverpool Lime Street Station
  - Liverpool One and Queen's Square bus stations

- Deploying 5G based broadband solutions to remote rural sites UK wide



Network delivered by utilising both local (EE, Vodafone, 02) and shared access spectrum for 4G and 5G services

Corporate office in Westminster. Development and research laboratory in Bath City Centre

Funded via private investors and four Government 5G programmes (c. £22m)

Network core co-located with UK operators in Telehouse North, London

UK's Largest holder of Local Access Licence Spectrum

Why are we interested in Spectrum Sharing?

- Access to usable mobile spectrum is essential to our business

- Procedure for spectrum acquisition has to be
  - Timely
  - Predictable
  - Cost effective

Dynamic Spectrum Access – a proven solution

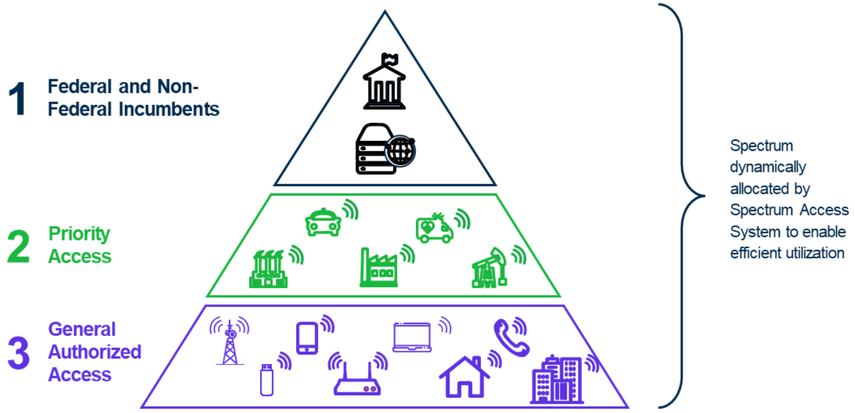
- Already lots of DSA ecosystems: **CBRS** [USA], **6GHz AFC** [USA, Canada] **TVWS** [UK, USA, Canada, Singapore…]
- CBRS the most successful so far:

420,000 ~~**285,000+**~~
CBRS base station nodes deployed in the US

~~**187**~~ **744**
CBRS base station (CBSD) models authorized by FCC to operate in CBRS

1,914 ~~**496**~~
Client Device (EUD) models authorized by FCC to operate in CBRS

~~**> 4,300**~~ **5,500**
Professional Installers are CBRS Certified

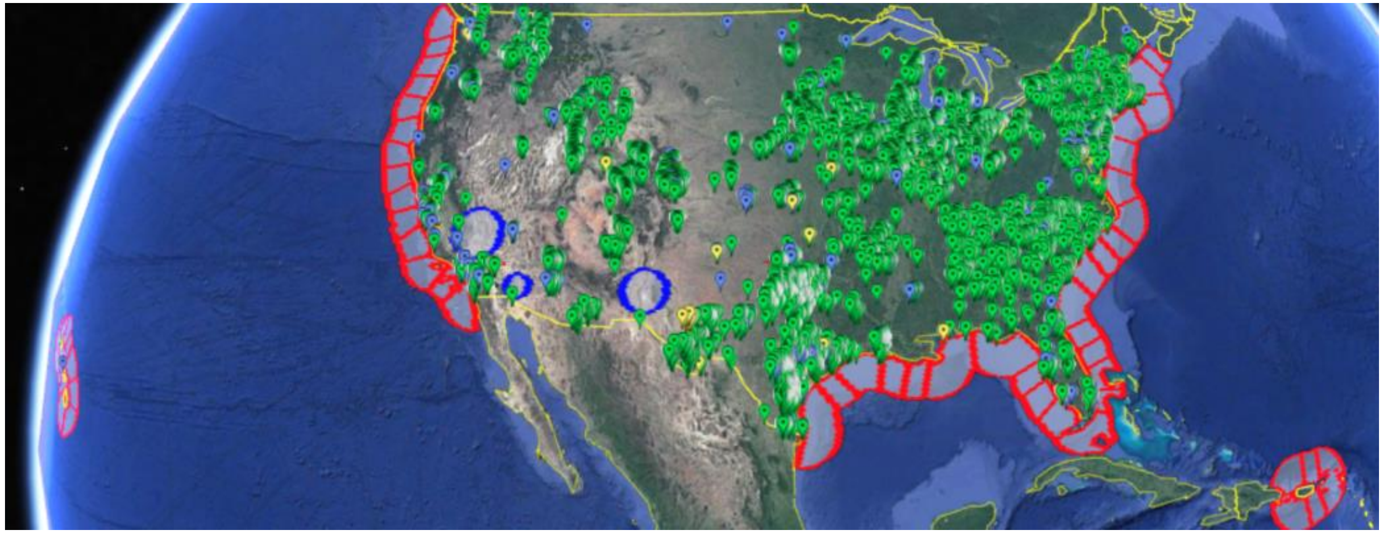


Priority Access

- 22,631 licenses issued via FCC auction in August 2020
- 228 diverse winning bidders committed over $4.5B to license rights
- Major licensees include Verizon Wireless, Comcast, Charter, Cox Communications, and DISH Wireless

General Authorized Access

- The GAA portion of the band hosts nearly 900 different users
- Including factories, cities, school districts, hospitals, research centers, schools, public libraries, utilities, and other critical infrastructure.
- Most importantly, unused PAL spectrum does not lie fallow, and can be efficiently put to use by GAA spectrum users.



About Us

Dr Alistair Braden

- UK-based Consultant R&D Engineer with 10 years in DSA, 4 years with Federated Wireless;
- Built operational TVWS databases for UK, USA, Canada;
- Worked extensively with Ofcom on the real-world practicalities of DSA;
- Invited speaker at Ofcom's *Understanding dynamic spectrum access* workshop (2022);
- Proposed & Built a DSA solution for SALs as part of DCMS-funded **5G New Thinking**;
- Built RF planning tools & propagation models for TVWS, CBRS & AFC, DSA for aviation;
- "Building Dynamic Spectrum Databases that work".

Federated Wireless

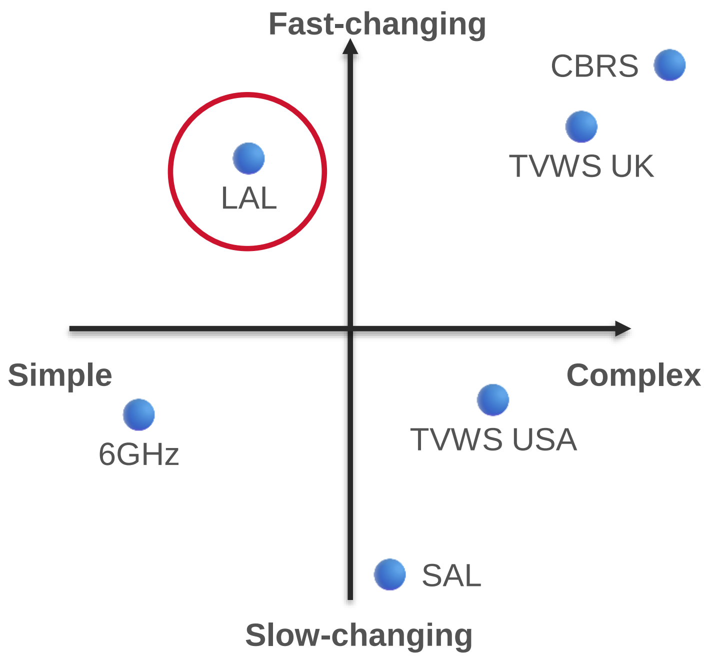
- Leader in DSA & Shared Spectrum, with 10+ years of advocacy and leadership in standards bodies;
- One of two main CBRS SAS providers, handling 200,000+ devices;
- Approved AFC provider in USA, application pending in Canada;
- Offices in the UK & USA;
- Partnered with Cisco & University of Strathclyde for DCMS-funded **5G New Thinking** project (2020-2022).

DSA in a nutshell

- DSA is a “hands-free” method for Ofcom to grant permission for a device to transmit for a given time;
- Automates the operator’s application *and* evaluating the application *and* granting permission
- Get a license in seconds, not months;
- Proven tools for Ofcom oversight and management;
- Coexistence with incumbents and peers is calculated automatically;
- Can compensate immediately when incumbent spectrum use changes;
- Suitable for any combination of licensed, unlicensed, and licence-exempt spectrum;
- Scales seamlessly to millions of devices and incumbents.

5G New Thinking’s New Thinking: DSA frameworks don’t have to be “big bang” launches, they can be a gradual series of steps **in between** fully manual processes (SAL & LAL at present) and fully automated processes (CBRS, AFC, TVWS), allowing proportionate levels of human intervention while the market and the device ecosystem mature.

DSA can enable Local Access Licences (LALs) to work in practice in a **timely, predictable, and cost-effective** manner for operators like Telet, while satisfying the needs of Ofcom and the incumbent MNOs.



WP1 Spectrum Sandbox Practical Test Beds

QMUL Spectrum Sandbox Stakeholder Workshop

11 June 2024

Department for Science, Innovation, & Technology

Telet: WP1 - Aim

WP1 will run a number of “experiments” that confirm the feasibility of automated 5G spectrum sharing in order to reduce time to obtain new Local Access Licences from 6-12 months down to sub-2 minutes

The aim:

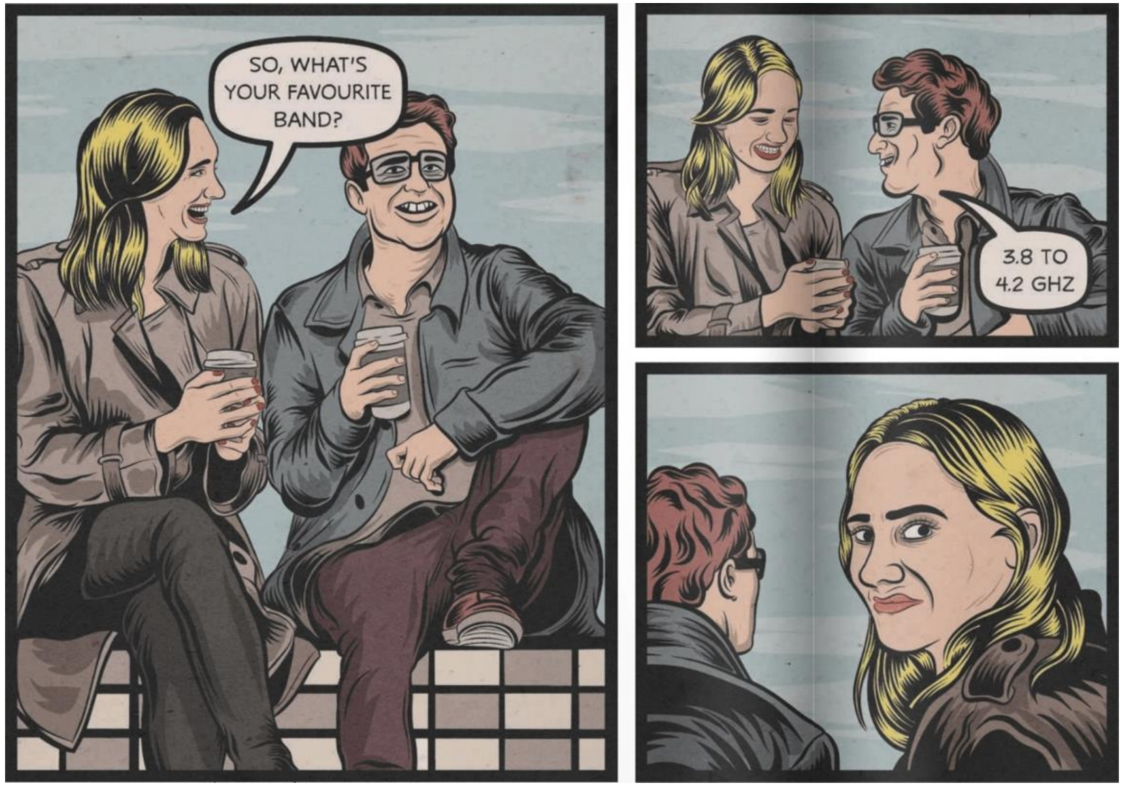
Demonstrate feasible spectrum sharing at Technology Readiness Levels 6 and above

Which Bands?

Each spectrum band has very different characteristics

Category	Focus Band(s)	Characteristics
MNO Licenced Bands	B3	Large band (2x75 MHz FDD) Any 3GPP waveform permitted All UK MNOs possess licences in B3 Current procedures require MNO approval
Shared Access	n77 (3.8-4.2 GHz) B3 (1800 MHz) B40 (2300 MHz) n258 (26 GHz)	Current procedures require Ofcom approval Bandwidth limitations (default min 5MHz) Power limitations Equipment compatibility
Licence Free	n46/n47 - Upper 5 GHz New - Upper 6 GHz	Currently used in China only Non-Interference not guaranteed Concerns about interference No existing band plans

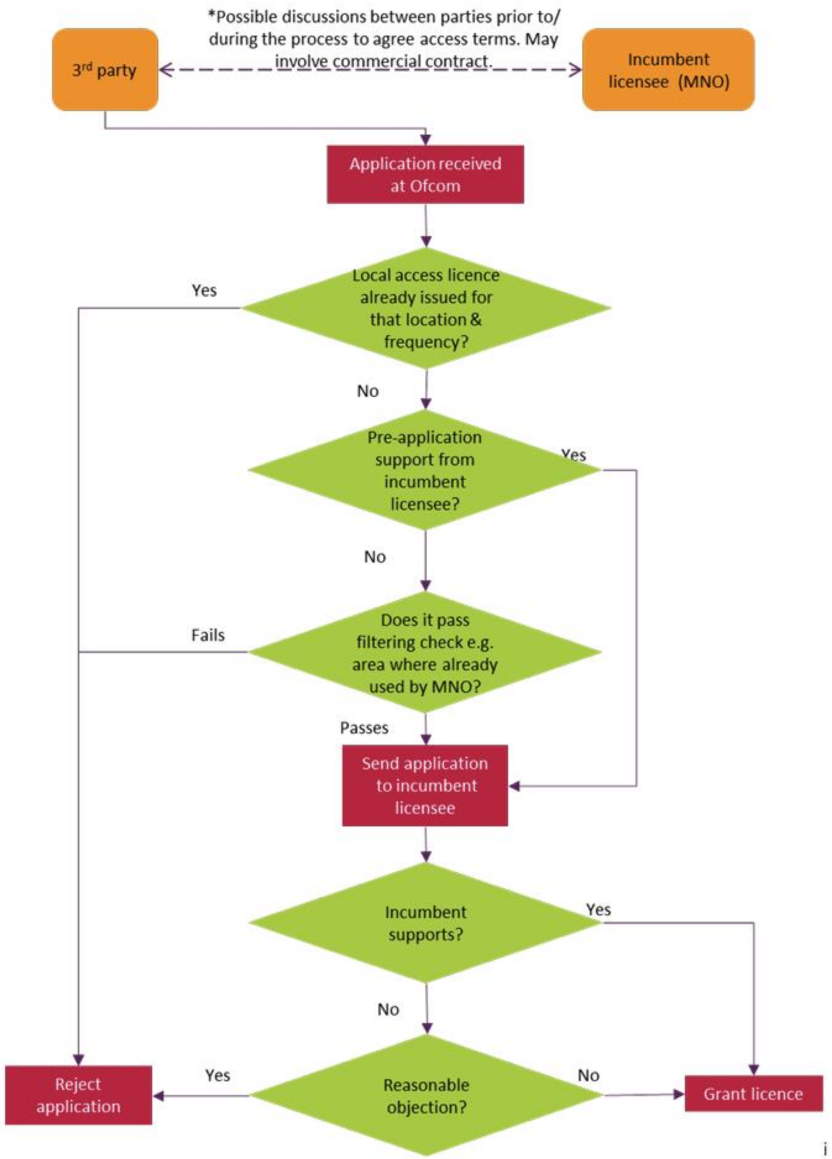
The 'Favourite' Band - n77



- n77 is unsuitable for neutral host operation
- Operator Carrier Profiles
- Limited to 5G NR Waveforms only
- Inter MNO roaming today requires 4G anchor channel (5G NSA) and 4G (DIAMETER) signalling

- We need access to bands that are licenced to MNOs in order to offer Neutral Host
- Band n77 is best suited to Private Network use only
- Focus on B3 (1800 MHz)

Finding a Solution for Everyone!



Existing LAL Procedure flowchart

- MNOs have paid £ Billions for spectrum
- Spectrum is valued as assets on Company Balance Sheets
- Essential that no devaluation occurs

- MNOs require **guaranteed access** to their licenced bands at all times without interference
- MNOs not happy with having to expend time and effort processing Local Access Licence applications under current procedures

Timely: Average delay between place application to receiving a response = 6-12 Months!

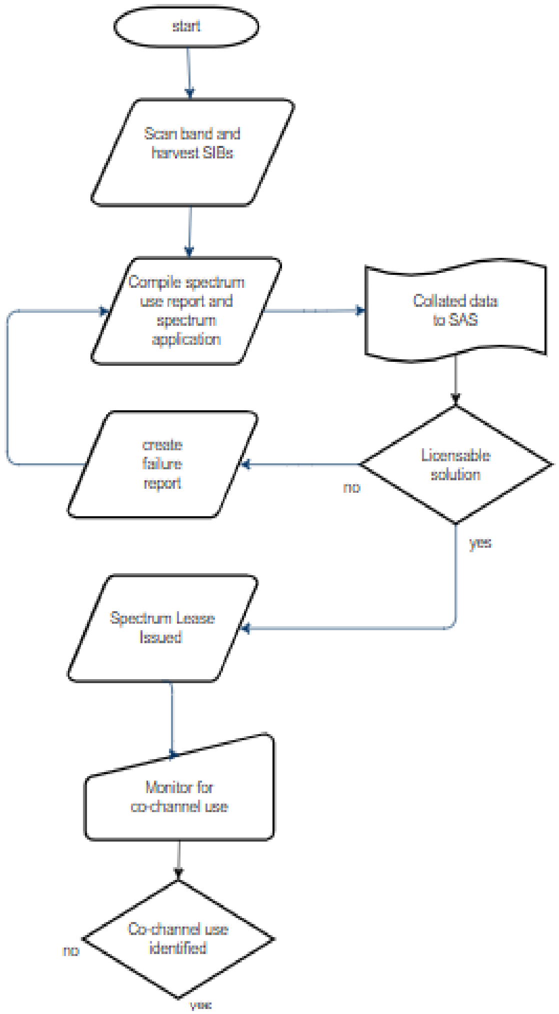
Certainty: Outcome usually uncertain

Economic Impact: Time and effort required to administer application is major for all parties involved

Finding a Solution for Everyone!

- Harvesting SIBs
- Generation of **Licensable Solutions**
- Feedback on spectrum application fail to enable rapid resubmission
- Spectrum lease achieved in 99% of cases
- Monitoring for co-Channel interference when in operation
- Detection of MNO usage triggers immediate release/

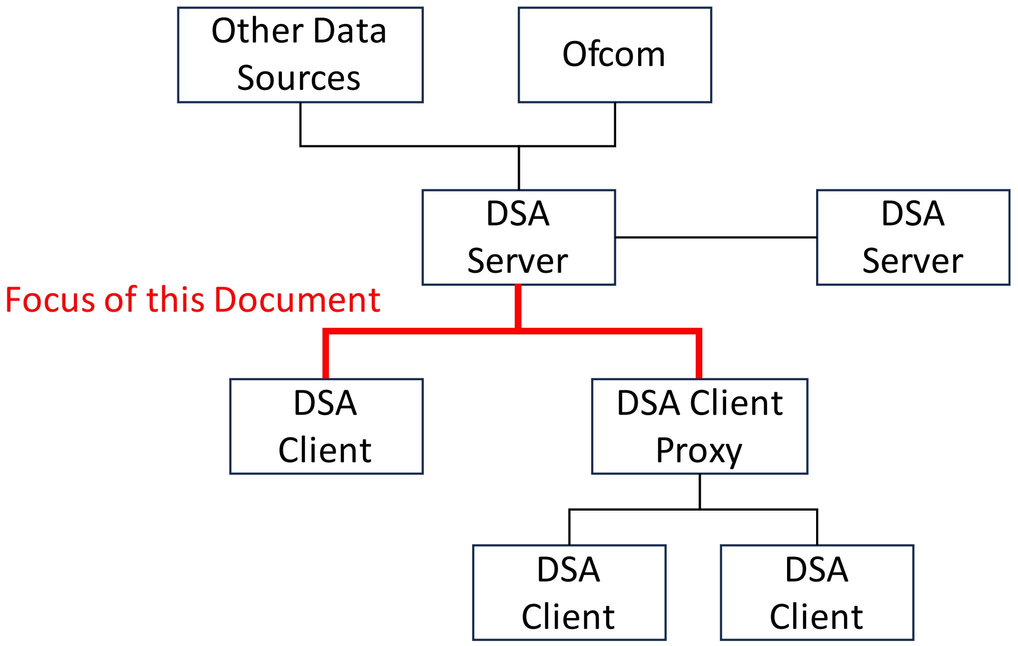
- Aim to demonstrate on two different platforms
  - Picocom PC802 based system
  - CellXica M5Q SDR



Federated Wireless Contribution

WP 1:

- Design and prototype a database-spectrum sharing solution to facilitate real-time DSA access to LAL spectrum
  - Measurements and incumbent detection from devices.
- Approach extensible to other bands (e.g., upper 6 GHz) and other services.
- Demonstrate with Telet research in Band 3



IDs	Description	[SAS-CBSD]	[AFC]	[5GNT]
	General			
S3, C6, P7	Secure REST	HTTPS/TLS	HTTPS/TLS	HTTPS/TLS
P8	Comms to Device	✓	✓	✓
P8	Proxy (batched)	✓	✓	✓
C7	Detect comms failure	Heartbeat	✗	Heartbeat
	Device Info to Server			
S4, C1	Antenna	InstallationParam	✗	InstallationParam
S4, C1	Site Locations	InstallationParam	Location	InstallationParam
S1	Varying Services	Air Interfaces (limited)	✗	✗
S4, C1	License info	Implicit	✗	*licenceId* or implicit
P5	Broadcast Info	✗	✗	Could overload Registration deviceInfo
P6	**Spectrum Inquiry**			
P6	Service area	✗	Polygons, Points	GeoJSON location
P6	Channels	*inquiredSpectrum*	*AvailableSpectrumInquiryRequest*	*inquiredSpectrum*
P6	Bandwidth	*inquiredSpectrum*	*AvailableSpectrumInquiryRequest*	*bandwidth*
P6	Min Power	*airInterface*	*minDesiredPower*	✗
P6	Max Power			*maxEirp*
P6	**Inquiry Feedback**			
P2	Coordinated Systems	✗	✗	✗
P6	Available Channels / Freqs	AvailableChannel	AvailableFrequencyInfo AvailableChannelInfo	*availableChannels*
P6	Transmit power	*maxEirp*	maxPsd	*maxEirp*
P6	Recommended Freqs	✗	✗	Optional
P3	Multiple configs	✗	✗	✗
S7	**Grant**			
S7	Variable period	heartbeatInterval	availabilityExpireTime	Heartbeat
S11	Dynamic preemption	Heartbeat	✗	Heartbeat
S14	Client Spectrum Confirmation	Heartbeat	✗	Heartbeat
P1	Changes in Grant	✗	✗	✗
C2	**Measurements**			
C2	RF Environmental Info	Indoor Loss, RF Power	✗	MeasReport
C3	Incumbent Detection	✗	✗	✗
S13	RF predictions to devices	✗	✗	✗
P9	Listen only	RECEIVED_POWER_WITHOUT_GRANT	✗	✗

Initial work studying suitability of existing protocols for desired DSA / real-time spectrum management protocol

Telet: WP1 – Deliverables

Desirable deliverables:

A way to fast track Local Access Licences

=> needed for Multi Operator Neutral Hosts

Telet: background

CEO: James Body
jb@tel.et
+44 7974 144172

CCO: Peter Gradwell
pg@tel.et
+44 7970 030010

Project lead: Ernest Hocking
eh@tel.et
+44 7421 098 483

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Overview of Simulation and Modelling

QMUL Spectrum Sandbox Stakeholder Workshop

11 June 2024

Department for Science, Innovation, & Technology

Ofcom

Simulation and Modelling Framework Development

- Develop a simulation framework integrating electromagnetic field modelling (using CST Microwave Studio or HFSS) and communication system modelling (using MATLAB, NS-3).
- Create a virtual environment replicating the real-world conditions observed in WP1's spectrum usage data, interference patterns, and signal characteristics.
- Study waveforms that are specifically tailored to be robust against interference from other users in the spectrum. This includes the creation of waveforms that can coexist with legacy systems without causing significant interference.

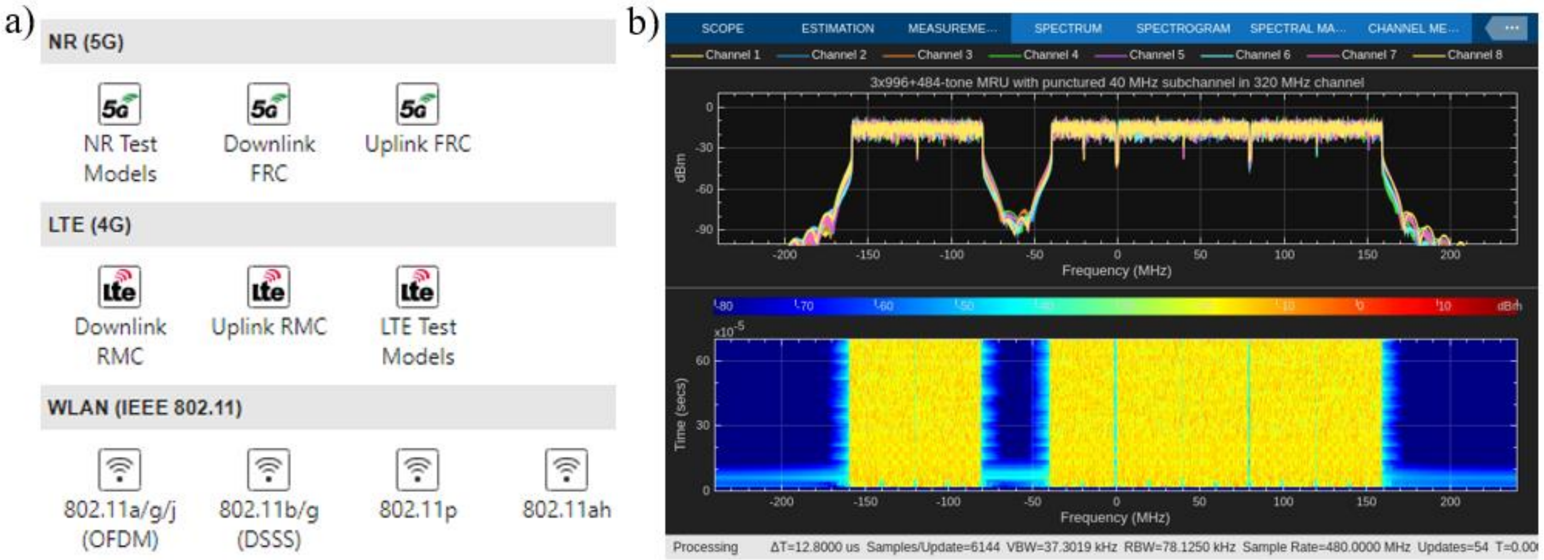


Figure 1: Panel a) The following waveforms can be generated for modelling/simulation and transmitting: 5G NR, LTE (4G) and multiple Wi-Fi protocols. Panel b) Once generated the waveform can be seen in the frequency domain in a spectrum analyser where also a waterfall plot shows the spectrum utilisation.

Federated Wireless Contribution

Characterise expected spectrum availability across UK under WP1 real-time spectrum sharing mechanism

- Band 3 given existing MNO reported coverage
- Alternate rules and assumptions
- Alternate bands

Prior simulation work studying spectrum availability under varying rules and assumptions in 3.8-4.2 GHz

Policy Summary	Area 0	Area 1	Area 2+	Population Weighted 0	Population Weighted 1	Population Weighted 2+
Existing Low Power	0.08%	<0.01%	99.90%	0.01%	0.05%	99.90%
No UK Broadband. Low Power	0.08%	<0.01%	99.90%	0.01%	0.05%	99.90%
Low Power SAL with Higher Fidelity Antenna Models	0.05%	<0.01%	99.90%	<0.01%	<0.01%	>99.9%
Existing Medium Power	12.30%	<0.01%	87.70%	77.50%	<0.01%	22.50%
No UK Broadband. Medium Power	12.30%	<0.01%	87.70%	77.50%	<0.01%	22.50%
Medium Power, 5 dB Less Interference Tolerance	12.40%	<0.01%	87.60%	77.50%	<0.01%	22.50%
Medium Power, 5 dB More Interference Tolerance	12.30%	<0.01%	87.70%	77.50%	<0.01%	22.50%
Decreased Medium Power EIRP	12.30%	<0.01%	87.70%	77.40%	<0.01%	22.50%
Decreased Medium Power EIRP, No Protection	12.20%	<0.01%	87.80%	77.40%	<0.01%	22.60%
Medium Power with Higher Fidelity Antenna Models	12.20%	<0.01%	87.80%	77.40%	<0.01%	22.60%

Table 7: SAL Availability in the UK With Higher Fidelity Antenna Modeling

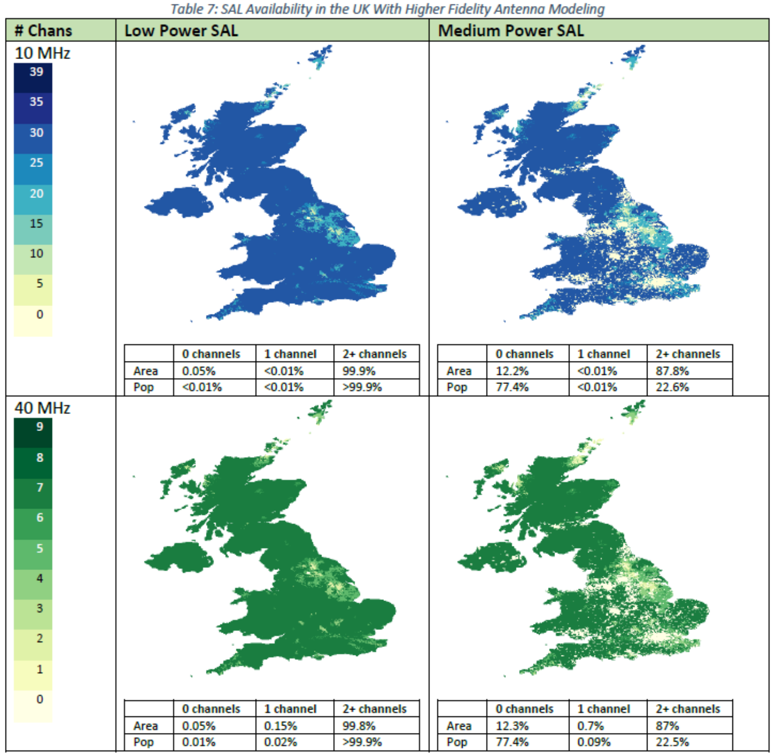
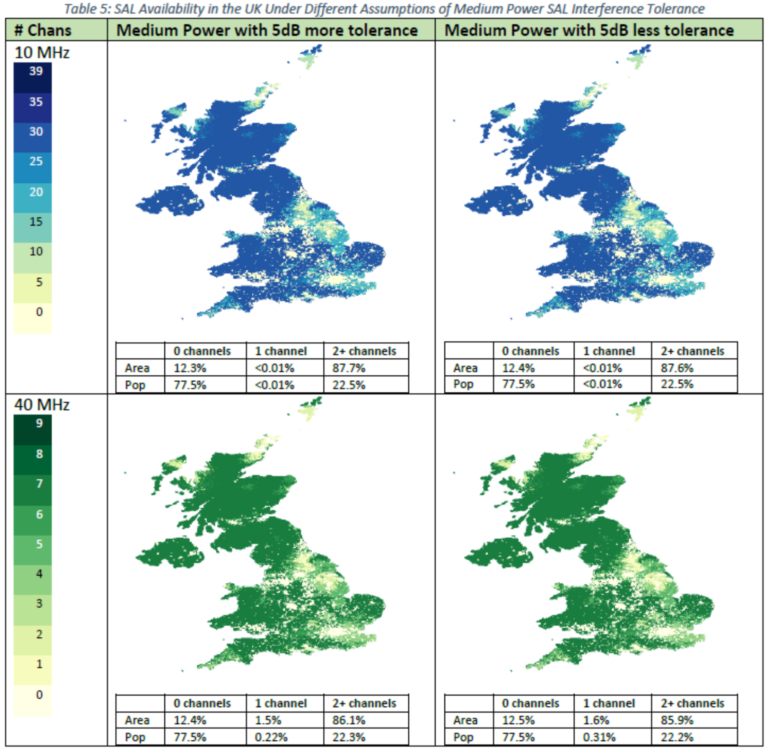
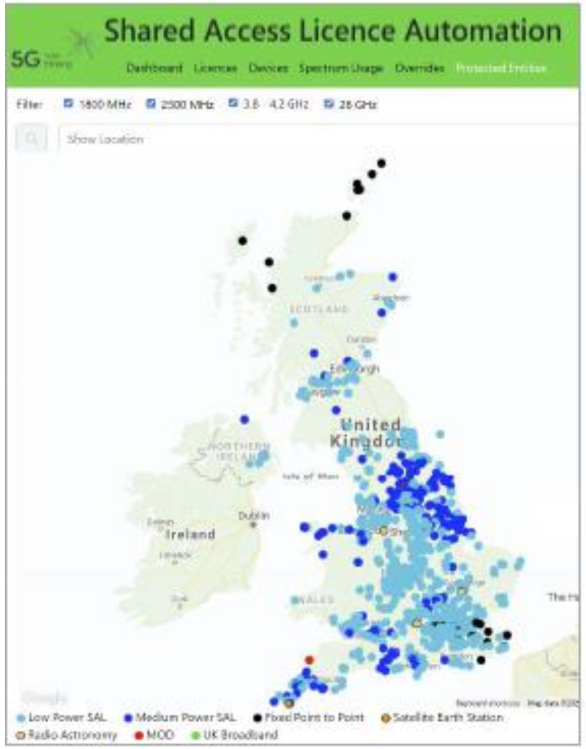


Table 5: SAL Availability in the UK Under Different Assumptions of Medium Power SAL Interference Tolerance





Machine Learning-Based Spectrum Sharing Optimisation, Validation and Iteration

Machine Learning

- Develop ML models to predict optimal spectrum sharing configurations based on historical data and real-time network conditions.
- Analyse patterns from past spectrum utilisation, interference levels, network performance metrics, and the effectiveness of sharing mechanisms to suggest optimal sharing strategies.
- Use supervised learning for prediction tasks, reinforcement learning for dynamic spectrum access strategies, and unsupervised learning to identify unknown patterns or anomalies in spectrum usage.

Validation and Iteration

- Compare simulation outcomes with empirical data and measurements from WP1, including spectrum usage patterns, interference levels, and signal propagation data.
- Conduct extensive field tests with Telet to validate the developed waveforms and their performance in real-world scenarios. This includes testing for compliance with regulatory standards and interoperability with existing systems.
- Adjust modelling assumptions and parameters based on discrepancies and reiterate simulations as necessary.
- Establish a continuous feedback mechanism to refine simulation models based on emerging new data from WP1 and WP3.

Data Sharing

- Frequency Bands: Information about which frequency bands are available for sharing, including licensed and unlicensed bands. Occupancy Rates: Data on how much and how often specific parts of the spectrum are being used by primary (licensed) and secondary (unlicensed) users.
- Time of Usage: Patterns of spectrum usage over time (time of day, week, etc.), which can help in predicting availability.

Other Parameters

- Waveform Types: Information about the types of waveforms used by different devices, including modulation schemes and bandwidth requirements.
- Power Levels: Transmission power levels used within the spectrum, which impact interference and coverage.
- Propagation Models: Data on how signals propagate in different environments, which affects how waveforms are modelled and managed.

By integrating WP1 data into the simulation and modelling framework, WP2 aims to deliver a detailed evaluation of dynamic spectrum sharing solutions, providing insights into their technical performance and economic viability for future 5G and beyond deployments.

Questions and Opportunities for User Engagement

- For a user engagement workshop centered on the Simulation and Modelling Plan for dynamic spectrum sharing, it's key to create an interactive and collaborative environment that encourages the exchange of ideas and the refinement of methods.

	Questions for Discussion
Performance Metrics	What are the most critical performance metrics for evaluating dynamic spectrum sharing solutions? How do these metrics differ across various applications or user needs?
Interference Management	What are the most effective strategies for managing interference between different waveforms? How can simulation help in understanding and mitigating these effects?
Real-World Data Utilisation	How can we effectively incorporate real-world data (from WP1) into the simulation framework to enhance its accuracy and relevance?
Waveform Design	What are the challenges in designing waveforms that are robust to interference? What features or characteristics should these waveforms have?
Legacy Systems Coexistence	How can new waveform designs be optimised to coexist with legacy communication systems without causing significant interference?
	Collaboration Opportunities
Joint Simulation Exercises	Organize joint sessions where participants can run simulations using shared tools and datasets.
Data Sharing Initiatives	Establish a consortium for sharing spectrum usage data and other relevant datasets among research institutions and industry partners
Standardisation Efforts	Collaborate on developing a set of standards or best practices for simulation and modelling in the context of dynamic spectrum sharing.

Are there any other suggestions that we should consider as part of our simulation and modelling activities?

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Overview of approach to economic modelling

QMUL Spectrum Sandbox Stakeholder Workshop

11 June 2024

Contents

1 Overall approach to economic assessment

2 Identification of use cases and benefits

3 Approaches to quantification of benefits

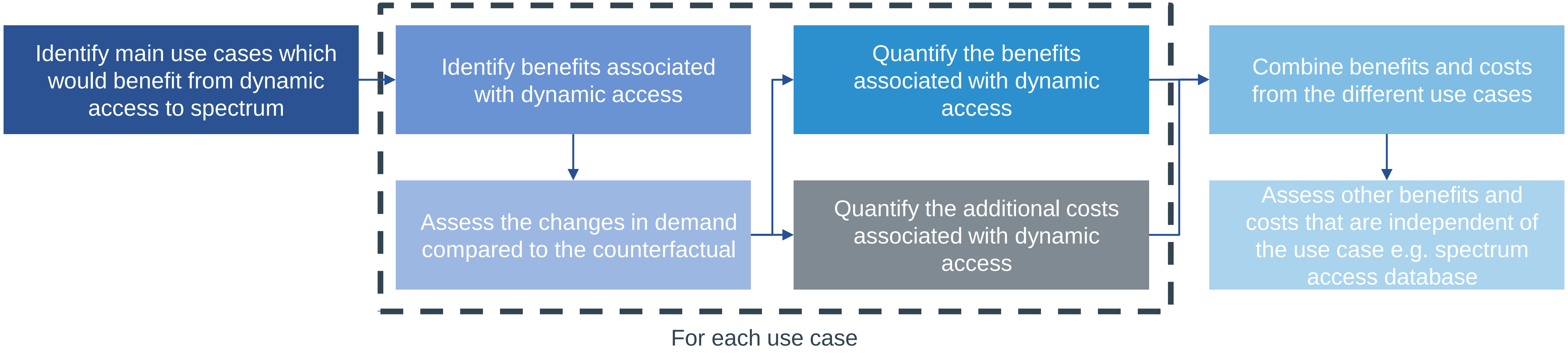
4 Scenarios for take-up of local access licences

5 Identification and quantification of costs

Overall approach to economic assessment

- In Work Package 3, our objective is to assess the **economic benefits arising from introducing dynamic access to spectrum currently licensed to the national mobile operators**
  - such dynamic access would be enabled through the use of advanced sensing technology and a dynamic spectrum assignment database – this is being trialled in Work Package 1
- We will focus on assessing the **incremental value** arising from **enabling dynamic access** to this spectrum – rather than the total benefits from spectrum sharing (part of which can be achieved under Ofcom's existing licensing approach)
- We will model the benefits and costs over a 30-year period (as suggested by DSIT) using a Net Present Value approach
- Examples of the benefits and costs we will consider as part of this approach include the following
  - **producer surplus** – the revenue that a producer (e.g. service provider) receives from selling their service minus the marginal cost of production (quantified)
  - **consumer surplus** – the difference between what consumers are willing to pay and the market price of a product/service (quantified)
  - **external value** – broader social values (e.g. more inclusive society) and other sources of value (e.g. investment spillover) (assessed qualitatively)

Methodology of cost-benefit analysis



Identification of use cases/benefits of dynamic licensing

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Local mobile providers

- **Use case**: Public and private mobile networks deployed by local providers
  - for example, private networks covering holiday parks or campsites
- **Benefits**
  - providing coverage in 4G/5G not-spots and partial not-spots
  - localised areas notionally covered by mobile operators but where user experience is inadequate
  - additional capacity for a temporary period in a local area (e.g. for festivals, concerts, sports events, other visitor attractions)

Fixed Wireless Access

- **Use case**: Additional source of 'low cost' spectrum for Fixed Wireless Access networks, leading to increased capacity and coverage of Fixed Wireless Access networks
- **Benefit**: Increased availability of superfast broadband over FWA

Additional spectrum for national mobile operators

- **Use case**: Use of spectrum by a different mobile operator in an area where the specific frequencies are not being used by the licensed mobile operator
  - Similar to the use of CBRS spectrum USA by the national mobile operators
- **Benefit**: Higher speeds and quality of service for mobile customers

Other local uses

- **Use case**: Utilising lower frequency ranges for deployments of private networks for use cases that require wide-area coverage
  - e.g. a port or corporate/university campus site
- **Benefit**: Reduced costs through lowering the number of transmitters required to cover the site

What other use cases might arise from introducing dynamic access to the spectrum?

Approaches to quantification of benefits

Local mobile providers

- **Benefit**: Extended mobile coverage
- **Size of opportunity**: To be evaluated using data on mobile coverage not-spots and results of measurements in WP1 and modelling in WP2
- **Quantification of benefit**: Assessments of customer willingness to pay for mobile connectivity (e.g. DEFRA report*)

- **Benefit**: Localised capacity for a temporary period
- **Size of opportunity**: Based on research on the number of events and their connectivity needs
- **Quantification of benefit**: Based on research on willingness to pay for connectivity by event organisers

Fixed Wireless Access

- **Benefit**: Increased superfast broadband connectivity
- **Size of opportunity**: Based on the number of premises that do not have access to superfast broadband and results of WP1/2 assessments on scope for spectrum sharing
- **Quantification of benefit**: Existing studies assessing benefits of providing fast broadband connectivity (e.g. DCMS Superfast Broadband Programme evaluation analysis**)

Additional spectrum for national mobile operators

- **Benefit**: Increased speed and quality of service for mobile customers
- **Size of opportunity**: To be evaluated using measurements from WP1 on scope for spectrum sharing and understanding of existing mobile operator spectrum deployments
- **Quantification of benefit**: Assessments of customer willingness to pay for improved quality of mobile service (e.g. DEFRA report*) and Aetha experience of quantifying benefits for mobile operators

Other local uses

- **Benefit**: Reduced costs through lower number of transmitters required
- **Size of opportunity**: Based on the market size of private networks requiring wide-area coverage
- **Quantification of benefit**: Based on research on the cost of deployments

* Estimating the value of mobile telephony in mobile network not-spots, RAND Europe for DEFRA, 2014

** Superfast Broadband Programme – State Aid evaluation report, Ipsos UK for Building Digital UK, 2023

Scenarios for take-up of local access licences

Counterfactual scenario

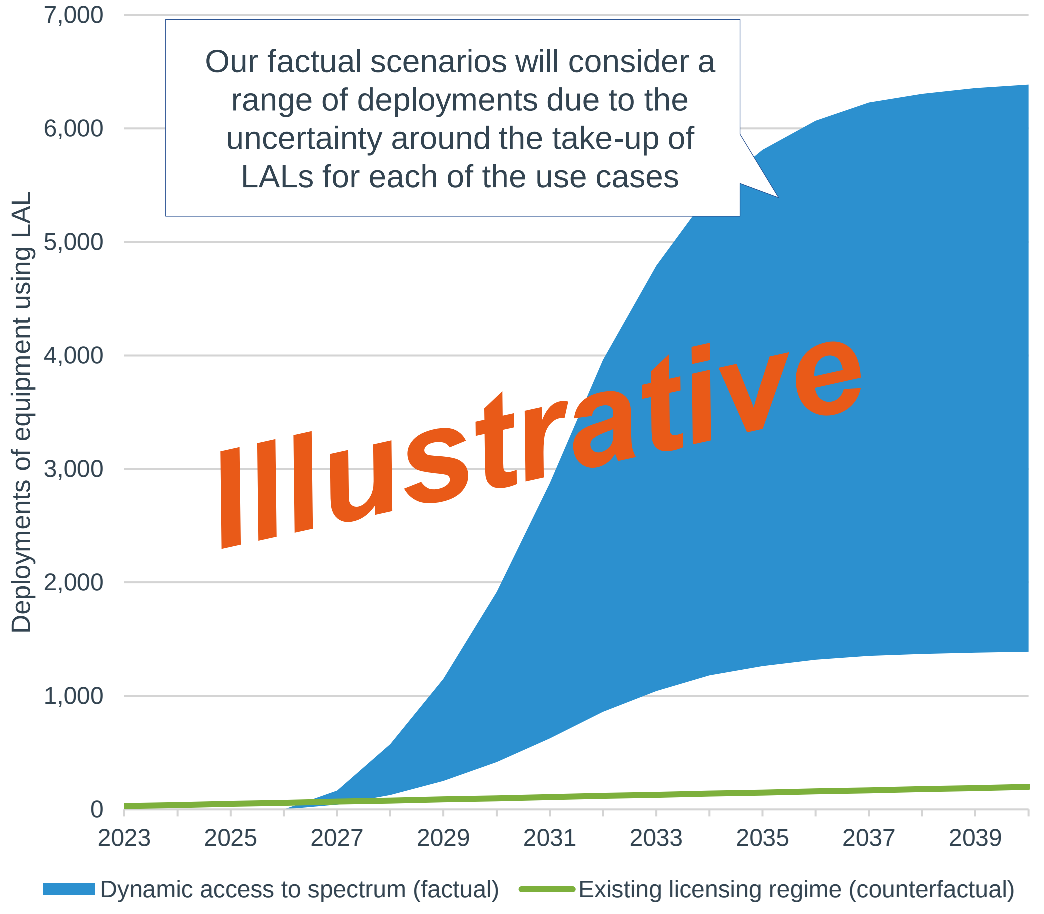
- Our counterfactual scenario assumes the current administrative licensing process operated by Ofcom continues indefinitely
- Our initial assumption is that the trends observed in the historical demand* for Local Access Licences (LALs) and Shared Access Licences (SALs) will continue in the short term
  – we assume a steady growth of local access licence take-up

* Source: Ofcom, Wireless Telegraph Registry, 16 April 2024

Factual scenario(s)

- Our factual case assumes that dynamic access to the spectrum licensed to the mobile network operators increases demand for (and hence the numbers of) local access licences
- Due to uncertainty regarding the size of the market opportunities of the different use cases, we will develop multiple demand scenarios
- Our forecasts will be informed by the results of the measurement and modelling work being undertaken in WP1 and 2 showing the size of coverage gaps and the extent of sharing that is possible in different geographic areas

Illustration of forecast of future local access licences



Do you have any views on the likely licence numbers in the factual and counterfactual scenarios?

Identification and quantification of costs

- As part of our analysis, we will consider the costs associated with dynamic access licences and compare them to the costs of the current licensing regime (the counterfactual)
  - we are interested in the incremental costs – those additional costs be incurred or saved by implementing dynamic access licences

Incremental costs of implementing dynamic access licences	Potential sources of information
Spectrum access system setup and maintenance	Outputs of WP1 + stakeholder engagement
Equipment on incremental sites / additional equipment on existing sites	Outputs of WP1 + research/stakeholder engagement
Installing sensing capabilities in base stations	Outputs of WP1+ stakeholder engagement
Ofcom staff to implement and manage spectrum access system	Stakeholder engagement
Increased risk of harmful interference	Outputs of WP1&2

Cost savings compared to the current licensing regime	Potential sources of information
Ofcom staff to process applications and address complaints	Stakeholder engagement
Costs (staff) related for organisations applying for a Local Access Licence	Stakeholder engagement
Mobile operator costs (staff) related to responding to applications for a Local Access Licence	Stakeholder engagement

Are there any other key costs that we should consider as part of our assessment?

Contact details

Amit Nagpal
Partner
amit.nagpal@aethaconsulting.com
+44 7546 912 355

Razvan Todoran
Manager
razvan.todoran@aethaconsulting.com
+44 7769 677 650

Harry Madden
Business Analyst
harry.madden@aethaconsulting.com
+44 7741 638 865

Miska Elliot
Business Analyst
miska.elliot@aethaconsulting.com
+44 7552 910 105

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

Queen Mary University of London

telet

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