Ofcom Spectrum Advisory Board

Annual Report 2022 - 2023

Publication Date: 15 September 2023

Contents

Section

Foreword from OSAB Chair 1

Foreword from the Spectrum Group Director 2

1. Overview 3

2. Highlights of OSAB Discussions 5

Annex

A1. OSAB Terms of Reference 13

A2. OSAB Membership 16

Foreword from OSAB Chair

Over the past year OSAB has covered the spectrum implications of a broad range of topics. These have spanned Digital Twins and Metaverse applications through to developments in the satellite industry encompassing direct to device calling, broadband connectivity and IoT capabilities. Ofcom's willingness to be innovative also resulted in excellent deep dives into the opportunities for sandboxes and adaptive spectrum access.

There has been strong engagement and interaction between OSAB members and Ofcom colleagues with all topics considered from the viewpoint of multiple different lenses. This is greatly facilitated by the broad range of skillsets that Ofcom ensures are collectively well balanced among the OSAB appointees. The current OSAB membership includes technologists (representing the service provider, equipment vendor and chip-set supplier perspectives), economists and policy experts. OSAB member's experience spans all phases of the development lifecycle from R&D through to in-life operation and includes representation from industry and academia with geographic experience spanning multiple continents. This ensures that OSAB is well placed to deliver on its remit of providing a holistic perspective on all things "spectrum" at Ofcom's behest. I am very pleased that as the new incoming Group Spectrum Director, David Willis has not only embraced OSAB but he has actively engaged in refining both the content focus and ways of working to further enhance OSAB's utility to Ofcom.

We can't manufacture more spectrum, yet demand for it is rising with the emergence of new technologies and use-cases. Hence optimising the efficiency of spectrum use in the UK is an ongoing task. I would therefore like to thank my fellow OSAB board members as well as Ofcom colleagues who contribute their time, not just to participate in OSAB meetings, but also the effort they put into preparing and pre-reading material in order to make OSAB meetings productive.

I look forward to addressing a range of new topics over the coming year.

Gavin Young

Foreword from the Spectrum Group Director

The Ofcom Spectrum Advisory Board (OSAB) has been an invaluable source of advice to Ofcom on all Spectrum matters since its establishment 19 years ago. It has provided insight into immediate issues, wide-ranging perspectives on ongoing policy projects, and suggested topics for longer-term study. By broadening Ofcom's understanding of key issues, OSAB has been an important contributor in enabling us to carry out our remit.

Thinking around how wireless telecommunications can be used and how spectrum can be allocated to effectively address the variety of wireless services continues to evolve. This past year we looked at the enthusiasm around virtual reality devices and the metaverse as potential new use cases we need to consider when allocating spectrum. We also continued to discuss new ways to share and allocate spectrum that will be indispensable to meet the needs of varied users in the future. As we published our statement on mmWave use cases as well as our consultation on Adaptative Spectrum Access, OSAB provided us with support and expert advice regarding how we should consider these areas of work.

As I approach the end of my first year leading Ofcom's Spectrum Group, I have appreciated the welcome and support from OSAB members. I have experienced the work OSAB does, and I highly value the support it provides to our policy discussions. Our new format for meetings with pre-readings and more specific discussion topics has been well received and has generated timely inputs to our work.

I look forward to continued engagement between Ofcom and OSAB and to ensuring the insights provided by its experts are integrated into our work and plans.

David Willis

1. Overview

Background

1.1 The Ofcom Spectrum Advisory Board (OSAB) was established on 19 May 2004 to provide independent advice to Ofcom on strategic spectrum management issues. OSAB provides Ofcom with:

a) A rapid way to test new ideas across a wide range of experts;

b) A means to identifying issues that are beyond Ofcom's regulatory "highlights"; and

c) A demonstration of Ofcom's commitment to consult in an open and collaborative manner

Organisational updates

1.2 A new Spectrum Group Director, David Willis, was appointed at the end of 2022. David follows on from Helen Hearn, who was leading the Spectrum Group on an interim basis since January 2022.
This year Niall Murphy stepped down from the board. We wish to thank Niall for his efforts and contribution to OSAB.

Annual Report

1.3 This document reports on OSAB activity from April 2022 to April 2023. It is intended to provide high-level highlights of discussions throughout the year and its content is based on minutes taken during the quarterly OSAB meetings.

Work Programme for 2022-2023

1.4 OSAB is responsible for agreeing its own work programme. During 2022-2023, the discussions were primarily focused on the following topics:

a) Spectrum Roadmap

b) Network requirements for a digital world

c) Spectrum sandboxes and the future of space communications

d) Reflecting on market mechanisms and adaptive spectrum access

1.5 Other relevant topics were also considered in 2022, such as Coase Economic Theory.

1.6 OSAB's membership spans a wide range of sectors and members' observations form an important part of the session. Round-the-table exchanges about developments in their sectors provide useful ideas and insights.

Future Meetings

1.7 OSAB sets its agenda from meeting to meeting depending on progress made in particular areas, time available and prominent topics arising. It deliberately does not plan a year ahead to allow for flexibility and responsiveness to development(s) in the telecommunications sector.

1.8 Recognising the flexibility that remote meetings have provided, whilst also understanding the significant benefits of in-person discussions, going forward OSAB meetings will be conducted in a hybrid manner.

2. Highlights of OSAB Discussions

Spectrum Roadmap

2.1 Following the publication of its Spectrum Roadmap, Ofcom gave a presentation focusing on Sections 4 (Key Market Trends and Developments) and 5 (Proposed Future Work Areas). The presentation highlighted three aspects: (i) Better Data for Spectrum Management, including more real-world data, is an opportunity to ensure spectral efficiency during policy development, allocation, and assurance of spectrum. (ii) Spectrum Sandboxes, a new activity within Spectrum, will differ from existing innovation and trials licensing process: (iii) The capabilities of Active Antenna Systems in improving spectral efficiency are being assessed through engagement with other administrations and manufacturers.

2.2 Discussions between the Board and Ofcom emphasised the importance of capturing the evolving environment of smart contract-based resource allocation, as well as opportunities to improve network management through Artificial Intelligence (AI), especially within the dynamic spectrum access and spectrum sandbox projects.

2.3 The Board emphasised that the balance between innovation and resilience had slightly shifted towards resilience in both networks supply chains and security, considering recent political circumstances such as the war in Ukraine and the Covid-19 pandemic.

2.4 Spectrum Sandboxes were highlighted as an opportunity to encourage and support collaboration between communities and industries that would not usually work together, as well as a potential environment to experiment with a dynamic database approach to high power shared access licensing.

2.5 Regarding Better Data, OSAB cautioned that while certain vendors might be able to provide anonymised real-world data to support Ofcom, it should not be made a requirement without protections, if at all. It was also noted that a Sandbox could be used to explore data collection mechanisms.

Network requirements for a digital world

2.6 OSAB's annual "deep dive" workshop in 2022 was used to explore the current and future network requirements arising from digital twins and the metaverse.

Digital Twins

Enabling digital twins

2.7 Mark Enzer from Mott MacDonald gave a presentation on enabling connected digital twins. Digital twins can be used to understand built environments better including physical infrastructure and assets, processes, and systems. The presentation flagged that use of connected digital twins would allow sectors such as water, energy, and telecoms to make better resilience decisions, faster. The presentation highlighted the importance of secure data sharing to enable connected digital twins – particularly for data collection and interventions, noting that this is where connectivity and communications solutions are needed.

2.8 Mark also explained that Digital Twins could become a core engineering component of the metaverse, described as the sum of all digital worlds. To conclude, Mark brought attention to the National Digital Twin Programme, aimed at using 'Data for the Public Good'[1], based on the idea of having an ecosystem of connected digital twins, facilitated by a data infrastructure, and enabled by telecoms (supported by Government policy).

Vodafone's work on digital twins

2.9 Boris Pitchforth and Dr Rebecca King from Vodafone gave a demonstration of a pilot digital twin, currently being further developed. This was a representation of both their mobile and fixed network, including the built environment. The model has fully mature GIS capabilities and Vodafone believes that the more real time, geographically accurate data they can gather, the more informed the Digital Twin will be. They expect this to reduce the number of site visits needed in the future, enable automated planning and a more resilient network, and help determine optimal deployment locations. Boris also shared a LIDAR-based model of a campus environment, highlighting the elevated levels of accuracy (down to half a cm) that this model can provide; this entails on-site measurement with a portable unit and/or drones.

2.10 Boris noted that there remain complexities around these approaches, particularly around the cost and management of data. For it to be successful, access to common, large datasets is needed. The presentation highlighted the difficulty of collaboration in this area, as it relies on information and data sharing through common models. There are no common rules for this, and relevant regulators could play a significant role in forming these.

[1] Data for the public good (nic.org.uk)

OSAB Discussions

2.11 OSAB members discussed the bandwidth, refresh rate, and overall spectrum requirements in relation to the amount of information and timing required by the Digital Twin use cases. It was noted that considering communication requirements from the start of the process is essential.

2.12 Members noted that digital twins could be used to improve mobile coverage reporting and questioned the presenters on the coverage of their Digital Twin. Presenters explained that access to the right data and common standards within the industry were key to allow digital twins to be widespread, accurate and enable data sharing.

The metaverse

Metaverse demo

2.13 Guillaume Lebrun from Meta gave a presentation on their own Metaverse project and the potential associated spectrum requirements for the future. The presentation noted that both technical and governance questions had yet to be answered, but that Meta was committed to push for an open and interoperable metaverse. Allowing users to create and use a diverse range of applications as efficiently as possible was established as a key priority of the company. High-capacity Wi-Fi enabling ultra-low latency was described as essential for the currently envisaged use cases, as virtual reality (VR) is to be used mostly indoors. New interesting use cases are expected to arise beyond 2025 which would require ultra-wide bandwidths, including sensing, ranging, and communications.

2.14 Regarding spectrum needs, Meta suggested more 3.4 – 3.8 GHz deployment from MNOs (Mobile network operators) will be needed for augmented reality (AR) in the future, and Wi-Fi 6E/7 (used to support current AR and VR applications) will require access to the full 6 GHz band. Additionally, the subpart of the 7-12 GHz range will be useful for ultra-wide band use.

5G, 6G, and the Metaverse: A Silicon Valley View

2.15 Prof. Mischa Dohler dialed in from Ericsson's Silicon Valley offices to represent Ericsson as well as the wider Silicon Valley views on the metaverse. He began by describing three beliefs on the topic: (i) it must embrace a social element, (ii) it must grow with the triplet of applications, networks, and devices, (iii) it will be accelerated by technologies such as Web 3.0 and AI. Regarding extended reality (XR) devices, Ericsson expects smartphones to evolve and to take on the bulk of this traffic for the foreseeable future. VR headsets, however, are likely to remain indoor only due to the hardware's nature and noted that there are challenges around access protocols, rather than capacity limitations. On the other hand, AR devices such as glasses, designed for outdoor use require the integration of all relevant technology in a way that seems too challenging for the moment. Still, there is a developing market in this area.

2.16 The presentation highlighted the need for mobile networks to densify and acquire more spectrum to enable the low latency and jitter requirements of this technology, as well as facilitate handovers between connectivity types. To this end, Mischa stated that mid-band spectrum would be the best to ensure consistent coverage and capacity. Finally, Mischa emphasised the importance of standardised interfaces and the surge in focus on metaverse standards, with a cross-company body formed to work on these. The presentation flagged the remaining challenges around ethics, privacy, and security, stating that it should not be left to private companies to solve these and should instead be tackled as a global effort.

OSAB Discussions

2.17 Board members queried whether there is a role for Wi-Fi sensing, particularly in the 60 GHz band. It was acknowledged that whilst the band is useful for very high-capacity Wi-Fi links, challenges remain around the power and coverage levels required, meaning that it is not robust for providing connectivity due to propagation characteristics.

2.18 A discussion around attitudes towards densification of mobile networks was had, with members highlighting that this will be required in the future but there remain challenges for MNOs. It is acknowledged that densification will be needed alongside spectrum and recognised that whilst 7-12 GHz is a sweet spot, there are already several incumbents.

2.19 Members noted the limited revenue drivers for 5G and queried the potential drivers for 6G in this area. Currently, 5G is expensive and does not have many business cases, new economic models are likely to be required to generate revenues and invest in their networks. Likewise, it was flagged that predicating our future on densification is not going to happen unless revenue can be seen in advance.

Spectrum Sandboxes

2.20 Ofcom gave a presentation on Spectrum Sandboxes, as laid out in our Spectrum Roadmap, published in March 2022. The presentation noted the potential for a sandbox to enable better sharing in the 3.8 – 4.2 GHz band. It was noted that sandboxes could also present us with an opportunity to explore how MOD spectrum can be better utilised, and shared. For incumbents that do not want to participate in sandbox activities, appropriate protection of their services will be ensured.

2.21 OSAB highlighted parallels with Spectrum Zones in the USA and flagged the importance of harmonisation and coordination with European initiatives, to ensure alignment and potentially lead the work in this area.

2.22 Questions were raised around coexistence between existing band users and sandbox users, as well as regarding geographical location and protocols around sharing of knowledge and intellectual property. Ofcom noted that the Spectrum Sandbox project was to be facilitated by Ofcom and led by interested stakeholders, whose engagement will be necessary to address practical challenges.

Direct to Device Satellite

2.23 Peter Hadinger from Inmarsat flagged both MNO and MSS spectrum as potential pathways for direct to device from satellite; he noted that the use of MNO spectrum would present complexity of alignment with national border coordination such as in Europe, requiring regulatory harmonisation. Challenges with obtaining sufficient contiguous spectrum were raised, as there are typically 1.5-3MHz channels required for LTE and people are looking towards a minimum of 5MHz channels for 5GNR. It was noted that different satellite operators use different power levels, which could introduce mismatch issues for coordination or out of band interference. Low earth orbit satellites tend to have higher power on the Earth's surface but have fewer filing rights than medium earth orbit and geostationary satellites in certain parts of the band and in certain parts of the sky.

2.24 Ofcom shared slides on direct to device satellite considerations from a regulatory point of view. Questions around the current technical constraints were raised, noting that the nature of signal losses could generally limit direct to device services to the sub-4 GHz bands.

2.25 Martin von der Ohe from Lacuna Space gave a presentation on Satellite connections for IoT devices. Lacuna offers a connectivity service for small amounts of data, targeted at remote IOT devices. The presentation stated that the satellite IoT market is estimated to grow at CAGR of ~20% between 2021-2028. Lacuna operates satellites as orbiting IoT gateways in the unlicensed spectrum in the SRD (short range devices) band, in accordance with non-interference and non-protection rules. The solution connects IOT devices on the ground directly to satellites. Lacuna supports device manufacturers by providing open-source hardware and software. The devices are designed to save energy, and Martin claimed that one unit can last several years on a single battery charge.

2.26 Vikram Raval presented on behalf of AST SpaceMobile. Gavin Young declared an interest as Vodafone have invested in AST but he is not directly involved. ASTs customers are MNOs looking to partner to provide direct to existing unmodified devices. AST SpaceMobile are aiming to help extend national mobile operators to connect unserved areas e.g. rural communities and see a demand for 2G, 4G LTE and 5G. AST deployed their test satellite BW3 in 2022 and are aiming to test broadband communications and intend to deploy 5 low earth orbit satellites in early 2023 to begin commercial services. AST's solutions is intended to work using unmodified mobile handsets and devices – adhering to 3GPP standards with MNOs utilising their existing allocated spectrum and thereby increasing more efficient use of existing spectrum. Coverage footprint of commercial satellites is intended to be around 2700km, and the beams can be controlled to narrower segments with then field of view and switched off individually if required using beamforming and other techniques and technologies.

2.27 OSAB queried about the risk of interference between satellites and the handsets they reach – the planned service is intended to manage interference in the manner that mobile operators usually manage interference for e.g. co-channel and adjacent channel, augmented with a range of other techniques. Members also asked about the relationship between AST and its competitors, to which Vikram replied that the feelings within the industry were generally positive and that there are a range of providers looking to serve this type of market. AST's distinguishing feature is to help mobile operators to extend broadband coverage.

2.28 A discussion took place regarding the best regulatory approach to enable direct to device services. AST expressed a preference for a national level approach over the slower international ITU approach. Ofcom colleagues noted that an international approach had the benefit of allowing a scaled ecosystem and easing coordination challenges, however acknowledged that this can move slower than national, or regional, approaches. In addition, the view on how to approach direct to device satellite communications at a regional level is changing.

Review of Market Mechanisms as applied to mobile spectrum in the UK

2.29 An overview of the Analysys Mason Report (2022) was given, and relevant Ofcom colleagues expressed that they were unconvinced that AIP and Auction mechanisms need reviewing at this time. While the report states that Annual Licence Fees (ALFs) are not necessary because spectrum is already efficiently allocated, Ofcom colleagues flagged that we have rarely witnessed trading or return of licenses despite the regime being designed to enable it. Colleagues noted that Ofcom seeks to create appropriate long-term incentives to ensure optimal use of spectrum and removing ALFs would mean relying solely on the willingness of users to trade unused bandwidth, which cannot be guaranteed.

2.30 Still, it was emphasised by Ofcom colleagues that our thinking surrounding market-based approaches was evolving, and we are considering a non-national fixed term license award as an alternative to ALFs at the end of the initial licence period within the mmWave project. These present an opportunity to renegotiate whereas indefinite licensing does not.

2.31 Whether mobile spectrum prices reflect the opportunity costs was raised as a crucial consideration. It was however noted that measuring the opportunity cost against the original price of spectrum is difficult as ALFs are not set until the initial licence period runs out. It was noted by some members that AIP is an effective way to enable opportunity costs; one example was provided of a company buying spectrum and trading to a different sector. Trades occurring from one use and sector to another were described as more likely than within the same sector.

2.32 OSAB members noted that new rules which would shift risk away from regulation and into the marketplace could encourage more innovation and risk-taking.

2.33 Board members questioned whether removing ALFs in favour of coverage commitments could be beneficial. Ofcom colleagues explained that these remain difficult to monitor.

2.34 OSAB described some market developments which Ofcom should consider when thinking in this area, including 6G, the growth of Mobile Private Networks, and new sharing mechanisms.

Ofcom statement and further consultation: Enabling mmWave spectrum for new uses

We are taking a proactive approach to making mmWave spectrum available, to enable investment in faster, better-quality services and innovation. We consider that making the 26 GHz and 40 GHz bands available for new uses at the same time will maximise this spectrum's potential to benefit people and businesses.

In our statement, we set out how we will allocate mmWave spectrum to best support new uses. We are also consulting on proposals for the design of the auction for citywide licences, the licence conditions for citywide and local mmWave licences and how we will coordinate users of this spectrum.

The statement can be found here.

Exploring the role of Adaptive Spectrum Access

2.35 A presentation was given by Ofcom colleagues on Adaptive Spectrum Access (ASA), as more dynamic, flexible, and adaptive access is seen as a potential solution to increase spectrum re-use.

2.36 Ofcom colleagues stated that the term 'adaptive spectrum allocation' has been chosen as an umbrella term, rather than the traditional term 'dynamic' as it allows Ofcom to consider alternatives to dynamic allocation, such as: 'opportunistic', 'top up' and 'flexible guarantee'

approaches. The presenters took us through the overall approach of the upcoming public positioning paper, noting that engagement with stakeholders has produced the sense that automated, rather than dynamic access, is preferred.

2.37 OSAB members raised the point that this could be challenging to implement and relies on engagement between equipment manufacturers and network stakeholders. They also noted that identifying orthogonal use cases is essential for this to be successful; whilst others highlighted that orthogonality of use patterns have become more sporadic.

2.38 Members suggested several use cases that could benefit from ASA, including uplink XR traffic, receiver standards and coexistence, sporadic, geographically localised and time infrequent cases and even satellite operations.

2.39 OSAB noted that ASA could benefit and improve possibilities of smaller businesses to enter the market, and that Ofcom should focus on bands where there is already an existing ecosystem of devices operating.

2.40 Still, members suggested this could only be worthwhile with large use cases and mass adoption. In addition, similar benefits to those ASA could offer could be reached through a well-defined open API which would enable more automated systems and better data.

Ofcom discussion paper: Opportunities for dynamic or adaptive approaches to managing spectrum in the UK

Enabling users to share spectrum in the most efficient ways is key to supporting the growth in demand for wireless spectrum and supporting innovation. In response to growing demand for spectrum, and in light of emerging technological developments, we have considered the potential benefits of more flexible and 'adaptive' spectrum management solutions.

In a discussion paper published in March 2023, we explore the opportunities and challenges associated with applying flexible, increasingly time-based spectrum management approaches (often referred to as Dynamic Spectrum Access) in the UK.

The discussion paper can be found here.

A1. OSAB Terms of Reference

Roles and Responsibilities

A1.1 Section 3 of the Communications Act, 2003 requires Ofcom to secure optimal use of the radio spectrum taking account of the different needs and interests of all users.

A1.2 The Ofcom Spectrum Advisory Board was established by Ofcom on 19 May 2004 and is a continuation of a group originally established by the Government in the 1990s to advise on wireless and which transferred to Ofcom with the Radiocommunications Agency.

A1.3 The role of OSAB is to provide independent, strategic advice to Ofcom on matters that directly, or indirectly, have a bearing on policy issues to do with future communications architectures; access methods; physical layer technologies; and spectrum services and applications. The provision of independent strategic advice will help Ofcom to carry out its remit.

A1.4 In formulating its advice, OSAB is to consider the future communications landscape from technological, economic, and societal perspectives, consonant with Ofcom's statutory duty to further the interests of citizens in relation to communications matters.

A1.5 In particular, OSAB is to advise on:

a) Ofcom's spectrum strategy, major UK national allocation decisions, spectrum management, and the application of spectrum pricing and trading

b) Issues that are currently "beyond Ofcom's headlights", to which Ofcom should start to give attention

c) New communications technologies

d) New means of managing the radio spectrum and their implications for Ofcom

e) Whether Ofcom's current and developing policy stance is appropriate and where new policy might be needed

A1.6 The OSAB may also be asked to advise on:

a) The extent to which future wireless and fixed communications infrastructure and services may be complementary or compete with one another

b) New and novel technologies

c) Emerging uses of spectrum in various sectors, for example, transport, healthcare, and scientific research

d) Ways to measure and assess the effectiveness of spectrum management policies

e) The development of market-led initiatives

f) The balance between licence and licence exempt spectrum

g) The stimulation of innovation through spectrum policy

h) Trends in international relations

i) Ways that spectrum policy could be used to further the interests of the citizen and consumer.

Membership

A1.7 Members of OSAB should be drawn from a mix of commercial, academic, and consulting backgrounds, in order to address topics in a multidisciplinary manner, and to advise Ofcom on matters of strategic significance in such areas as future communications architectures, access methods, physical layer technologies, spectrum, services and applications.

A1.8 Membership of OSAB will include ex-officio members from His Majesty's Government and relevant experts who work for Ofcom; such ex-officio members participate fully in discussions but reserve the right to abstain from agreement on substantive matters. . All members shall be appointed by Ofcom, following the advice of the Group Director of Spectrum. The Group Director of Spectrum also seeks the approval of the Ofcom Chief Executive for the appointments.

A1.9 OSAB shall have a quorum of 6 members, one of whom must be the Group Director, Spectrum Group or their designated Alternate and excluding ex-officio members. Members attendance through telephone or video link is acceptable for the purposes of determining a quorum.

Conduct of Meetings

A1.10 An independent member (not an employee of Ofcom) will be appointed by Ofcom to chair OSAB meetings.

A1.11 OSAB shall meet four times per annum. Ad-hoc meetings of OSAB can be arranged, if necessary, with the agreement of the Chair.

A1.12 Where the Chair of OSAB considers it appropriate, matters may be considered in between meetings by email.

A1.13 Papers shall be circulated at least 3 working days before each OSAB meeting. Extensions to this will be on an exceptional basis and must be agreed by the Chair.

A1.14 To avoid any conflict of interest, members of OSAB will not have access to confidential information pertaining to Ofcom decisions affecting specific companies. This does not however preclude the discussion by members of potential Ofcom policies.

A1.15 Persons other than Members are permitted to attend meetings for particular items if the Chair of OSAB agrees.

A1.16 OSAB meetings will be supported by a Meeting Secretary and minutes and an action log will be prepared after each meeting.

A1.17 The Terms of Reference shall be reviewed periodically, as, and when required by Ofcom. Any amendments shall be approved by the Ofcom Chief Executive, usually via the Ofcom Policy Management Board (PMB).

A2. OSAB Membership

External Members

Gavin Young (Chair)

Gavin's current role is as Head of the Fixed Access Centre of Excellence within Vodafone. He is responsible within Vodafone Group for the fixed broadband access strategy, architecture, and deployment practices across the 17 countries where Vodafone currently has fixed access assets.

Gavin was previously Head of Strategy and Planning at Cable & Wireless Worldwide, leading a team of architects responsible for the technology architecture and strategy. He had previously worked at Bulldog Communications (later acquired by C&W Worldwide) where he held a variety of responsibilities from product development through to network operations and CTO. Prior to that Gavin led the Access Architecture & Design team at BT.

Gavin was a founding director of the Broadband Forum where he was overall Technical Chair for twelve years. In addition, he has been co-chair of the UK21CN consultation's Broadband Group, chair of the UK NICC's DSL Task Group and vice-chair of the NICC Ethernet Access Task Group. Gavin also serves on the IET (Institution of Engineering and Technology) Communications Policy Panel, the Ofcom Spectrum Advisory Board (OSAB) and the Broadband Forum's executive advisory board. Gavin is a member of the IEEE, Fellow of the IET and Distinguished Fellow of the Broadband Forum.

Professor Mischa Dohler

Mischa Dohler is vice president of emerging technologies at Ericsson in the Silicon Valley. He is a Fellow of the IEE, the Royal Academy of Engineering, the Royal Society of Arts (RSA), the Institution of Engineering and Technology (IET); and a Distinguished Member of Harvard Square Leaders Excellence. He is a serial entrepreneur; composer and pianist with five albums on Spotify/iTunes; and fluent in six languages. He acts as policy advisor on issues related to digital, skills and education. He has had coverage by national and international press and media.

He is a frequent keynote, panel, and tutorial speaker, and has received numerous awards. He has pioneered several research fields, contributed to numerous wireless broadbands, IoT/M2M and cyber security standards, holds a dozen patents, organised and chaired numerous conferences, was the Editor-in-Chief of two journals, has more than 200 highly cited publications, and authored several books.

He was the Director of the Centre for Telecommunications Research at King's from 2014-2018. He is the co-founder of the Smart Cities pioneering company Worldsensing, where he was CTO from 2008-2014. He also worked as a Senior Researcher at Orange/France Telecom from 2005-2008.

Greg Bensberg

Gregory Bensberg is the Managing Director of Digital 3&4 Limited, the UK's main commercial public service DTT (Digital Terrestrial Television) multiplex, carry ITV and Channel 4 services to over 98% of UK households. He is a leading authority on both the technical and regulatory aspects of digital broadcasting and has over 30 years' experience as a regulator and digital broadcast engineer. He is also the chair of the 5G Media Action Group's regulatory, spectrum and policy group.

He has previously worked as a policy and technical expert for Ofcom, the UK government, and the Independent Television Commission for over 20 years. He acted as a key technical and regulatory adviser to the UK government during the development of the UK government's switchover policy. He was also responsible for leading Ofcom's spectrum clearance programme (800 MHz and 2.6 GHz) which enabled the UK's 4G spectrum auction in 2013 and the development of the UK's UHF strategy.

Gregory is a chartered engineer and holds an MBA and BSc. He joined the ITC in 1992 after spells working for Marconi, the IBA, Quantel and Thames Television. He was awarded an MBE in 2014 for services to communications and media.

Wassim Chourbaji

Wassim Chourbaji is Qualcomm's Senior Vice President and Head of Government Affairs for Europe, the Middle East, and Africa. He oversees Qualcomm's public policy, regulatory affairs, and senior government relations in the region. Mr Chourbaji leads a senior team dealing with innovation, 5G, intellectual property, digital economy, spectrum, standardisation, data protection and anti-trust policy. Mr Chourbaji studied engineering and mathematics.

Peter Pitsch

Peter Pitsch currently consults for the C-Band Alliance. Peter Pitsch was Associate General Counsel at Intel Corporation, specialising in communications policy matters. Peter was Chief of Staff to the Chair of the FCC from 1987 to 1989 and Chief of Office of Plans and Policy from 1981 to 1987. From 1980-1981, Peter was a staff member of the Reagan Administration Transition Team.

Peter received a B.A. in Economics from the University of Chicago in 1973 and his J.D. from Georgetown University Law Centre in 1976.

Rosalind Singleton

Rosalind Singleton is a CEO, board chair, NED, advisor, and investor with over 30 years of experience in the technology sector. She is the CEO of Spring Fibre, an FTTH start up and the Chair of the Telecoms Supply Chain Diversification Advisory Council. The Council represents an opportunity to provide

independent challenges and advice to the government in policy development and act as a voice for the industry on the topic of 5G supply chain diversification.

For the last five years Rosalind has been an active angel investor and mentor and has led several deals, focussing on tech businesses with a female founder. She is a member of the Angel Academe Advisory Board.

Rosalind joined UK Broadband in 2013 and was Managing Director from 2017 until it integrated into its parent company in 2019 following its delivery of the ThreeBroadband 5G launch network. She has previously held senior roles at BT Openreach, Cable and Wireless, Vodafone, various VNOs, and other international operators from start-ups to incumbents.

Rosalind is a member of the UK Government's Telecoms Supply Chain Diversification Advisory Council and Ofcom's Spectrum Advisory Board. She is an Independent NED on the board of Alphawave IP (Internet Protocol) Group PLC, a silicon IP business providing high speed connectivity solutions for global large an hyperscale customers.

Peter Hadinger

Peter Hadinger is the Chief Technology Officer at Inmarsat. Peter and his high calibre engineering team are developing next generation technologies and satellite infrastructure that will enable innovative connectivity services and solutions across land, sea and in the air. These services and solutions sustain operational, safety and mission critical applications for businesses and governments across the world.

After joining Inmarsat in 2011 to help develop the market-leading Global Xpress programme, Peter became President of the business unit responsible for US Government sales and programmes at Inmarsat and subsequently became CTO in late 2017. Prior to joining Inmarsat, Peter spent 30 years as a leader in technology development, engineering, and government spacecraft programmes at Northrop Grumman. He holds multiple patents in advanced communications technology and systems.

He also has a diverse regulatory and policy background, having successfully led industry efforts in the World Trade Organisation (WTO) Telecom Services Agreement, the Federal Communications Commission (FCC) World Radio Conference Advisory Committee, the President's National Security Telecommunications Advisory Committee, plus a one-year fellowship in the United States Senate.

Peter received his Bachelor of Science in Electrical and Electronic Engineering from California State Polytechnic University, an MBA with emphasis in finance strategic planning from George Mason University and serves on engineering advisory boards at Virginia Tech. He was inducted into the Cal Poly Pomona Engineering Hall of Fame in 2014.

Alastair Macpherson

Alastair Macpherson was the partner leading PWC's economic practice and specialising in the communication and other regulated sectors. He has advised numerous operators, regulators, and governments around the globe. A major part of his interest and work has focused on the debate

defining the appropriate form of regulatory intervention in the case of market failure in the communications and technology sectors in the face for technology change. He also advises clients in other regulated sectors including posts, health, and water. Alastair has acted as an expert in regulatory, competition and arbitration proceedings including the UK Competition Commission, Competition Appeals Tribunal, European Commission DG Competition, and the London Court of International Arbitration.

Prior to joining PWC, Alastair worked at BT PLC where he held various roles in corporate finance, new businesses, and regulatory affairs.

David Meyer

David Meyer is a former central government Chief Information Officer and was previously a senior army officer in the Royal Corps of Signals. In the course of his career, he has worked in the UK Government digital and cyber risk fields, and on electromagnetic spectrum policy issues with Ofcom, industry, and the Government.

David chairs a private limited company, DMSL, trading as 'at800', and has been a member of the Ofcom Spectrum Advisory Board since 2009, acting as chair prior to Linda Doyle. He has also chaired an industrial technical body, the Spectrum Policy Forum, since 2016.

Dr Robert Pepper

Robert Pepper is Head of Global Connectivity Policy and Planning at Meta focusing on global, regional, and national infrastructure and connectivity including new technology development, deployment, adoption, and policy/regulation. Robert was previously Cisco's Vice President for Global Technology Policy, helping governments develop national digital strategies, address wireless and spectrum policy, security, privacy, and internet governance.

Pepper was Chief of the Office of Plans and Policy and Chief of Policy Development at the United States FCC for fifteen years, where he led teams designing and implementing the first U.S. spectrum auctions, developing policies promoting the development of the Internet, implementing telecommunications legislation, and planning for the transition to digital television. He also led the Office of Policy and Development at United States' National Telecommunications and Information Administration.

His academic appointments included faculty positions at the Universities of Iowa, Indiana, and Pennsylvania, and as a research affiliate at Harvard University. He is a member of the Board of Trustees of the Internet Society and the board of the US Telecommunications Training Institute and is a member of advisory boards at Columbia University and Michigan State University. He has chaired the US Department of State's Advisory Committee on International Communications and Information Policy and served on the US Department of Commerce's Spectrum Management Advisory.

Pepper received his BA and PhD from the University of Wisconsin-Madison.

Ex-Officio Members

Cristina Data

Cristina is the Director of Spectrum policy and analysis, Spectrum Group at Ofcom and is also an NED of the Energy System Catapult and sits on the Digital Twin Strategic Advisory board hosted by the Connected Places Catapult. Cristina is leading work to understand the long- term impact of technology, market, and international changes on our spectrum management activities. Prior to joining Ofcom Cristina held various market and business intelligence roles within strategy at Telefonica O2 setting up a framework to benchmark data growth across different countries, financial planning, and analysis at Orange UK, looking at the profitability of different marketing initiatives and market research and intelligence at Red Bee Media where Cristina had the responsibility to set up the entire unit. Cristina holds a master's degree in Industrial Engineering from the Politecnico di Torino university in Italy.

Holly Creek

Holly Creek is Deputy Director for Wireless Infrastructure, Spectrum and Consumer Policy within the Department for Science, Innovation and Technology. She has over 20 years' experience working in a variety of roles in central Government and at regional level, managing high profile and complex policy and legislation across numerous sectors including digital infrastructure, media, and the creative industries.