7

SPECTRUM MANAGEMENT

Anne Flanagan[1]

7.1 INTRODUCTION

Developments in communications and broadcast, in addition to wireless technologies, have greatly increased the demand for radio spectrum, an 'invisible' natural resource that is, practically speaking, finite or scarce. Although the last decade has witnessed the phenomenal growth worldwide of mobile terminal equipment and wireless networks and services, commentators advise that we 'ain't seen nothing yet'[2] and are merely at the start of what will be possible with the 'marriage of high-quality, super-fast mobile connections and billions of devices'.[3] Various factors have contributed to these developments which may ultimately bridge the 'digital divide',[4] including the evolution of mobile broadband internet

[1] The author thanks Geoff N Chapman (MA, MSc, PhD) and Renee Greenberg (BA, JD) for their research assistance.

[2] Bachman—Turner Overdrive 'You Ain't Seen Nothing Yet' (Mercury Records 1974).

[3] Enter, R, 'The Wireless Industry: Revisiting Spectrum, The Essential Engine of US Economic Growth' (Recon Analytics April 2016).

[4] See eg Smith, A, 'U.S. Smartphone Use in 2015' (Pew Research Center, Pew Hispanic Center, 1 April 2015) (noting that while that growing numbers have access to digital technology in the US with 64% of Americans adults owning a smartphone, that non-whites (12% of Black and 13% of Hispanic Americans) have access to the internet only on their mobile phones, compared to 4% of whites. Also, penetration rates in Africa, while significantly lower than much of the world, are increasing annually although cost and quality issues

Anne Flanagan, 7 Spectrum Management In: Telecommunications Law and Regulation. Fifth Edition.
Edited by: Ian Walden, Oxford University Press (2018).
DOI: 10.1093/oso/9780198807414.003.0010

technologies, the migration of telecommunications providers to IP networks, the development of reasonably priced 'smart' handsets, constantly evolving digitized mobile multimedia and other content, mobile software applications and services, maturing markets for mobile voice telephony, and the growing demand for ubiquitous internet connectivity.

The next if still emergent evolution, or 'generation', of wireless technology—'5G'—with its goals and projected performance requirements is likely to see unprecedented demand for electromagnetic spectrum,[5] the medium or 'pipe' over which such mobile voice and data and other communications services are provided. Spectrum can be considered a continuum of all electromagnetic energy waves according to their frequency, height (called 'amplitude'), and wavelength with ensuing propagation and other characteristics. The segment suitable for carrying sound, images, and other data is found in the electromagnetic waves at the lower end of the electromagnetic frequency continuum, encompassing eg 'radio', 'micro', and 'short' waves, which we will call 'radio spectrum' or 'spectrum'. Although theoretically infinite and physically inconsumable, spectrum has practical limitations as a particular usage can cause interference with competing uses in the same and neighbouring 'bands' of waves because the low of one wave can disrupt the high of another. This interference potential causes spectrum to be described as 'scarce' since often only a limited number of users (possibly only one) can operate effectively within/near a band. Also, certain technologies work better within different wave bands' technical characteristics. This and interference have traditionally driven policy regarding spectrum's allocation and regulation. Existing frameworks at the national, regional, and international levels have been directed at putting in place systems for coordinating and allocating bands of spectrum for specified uses according to their characteristics and potential for interference. At the national level, the means utilized to control this are generally government licensing for access to use spectrum in specified bands under specified condition/conformity requirements.

Ongoing technological developments such as digitization, advanced compression technologies, cognitive radio and intelligent antennas, MIMO, beam forming and multipath propagation, and spread spectrum, etc have greatly minimized 'scarcity' and allowed for greater capacity. Despite this, experts conclude that

remain, see ITU, 'Percentage of Individuals Using the Internet 2000–2016', 2017, <https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx>.

[5] See eg White, B, Keysight Blogs: 'FCC 5G spectrum allocation demands 3 breakthrough innovations' (Keysight Technologies, 29 July 2016) (noting the FCC's recent allocation of 11Ghz combined licensed and unlicensed spectrum for 5G use is 200 x that allocated for the first cellular analogue communications), <https://community.keysight.com/community/keysight-blogs/insights-outside-the-box/blog/2016/07/29/fcc-5g-spectrum-allocation-demands-3-breakthrough-innovations>.

the unprecedented and growing demand for spectrum, including notably for mobile data broadband services, will shortly outpace its availability.[6] To address this problem so that further innovation and the economic and social growth possible[7] with mobile technologies are maximized, policymakers and regulators are examining their current policies, allocations, and uses of allocated spectrum.[8] Various complex strategies are being used or, at least, considered to promote more efficient and effective use of spectrum and further its potential availability, including the 2016–2017 US 'voluntary incentive auction' that required several stages of a reverse auction and then a forward auction after the FCC's 'repacking' of spectrum returned by broadcasters for its reallocation and licensing in contiguous blocks.[9]

This US effort, proposed in its 2010 National Broadband Plan, is a regulatory option available for currently underused but allocated spectrum: its repurposing, or 'refarming' to more valuable uses or to the same use but using more efficient technology that requires less bandwidth or has less risk of adjacent bandwidth bleed. Refarming has been of considerable recent significance with the reallocation in various jurisdictions of what is called the 'digital dividend', or, the spectrum used by bandwidth-hogging TV analogue broadcasts, including in the 700 and 800 MHz bands[10] discontinued with the switchover to digital television that uses digital compression technologies permitting at least four channels to operate in the same spectrum bandwidth as one analogue channel. These more efficient digital TV services take up less bandwidth freeing the remainder for new uses. However, exploiting this 'digital dividend' has not been problem free. In the UK, Ofcom estimated that as many as 2.3 million households would be affected

[6] See eg FCC Staff Technical Paper, 'Mobile Broadband: The Benefits of Additional Spectrum', October 2010 (noting that demand for mobile data is expected to grow between 25 and 50 times current levels within five years in light of take up of smart devices, producing a spectrum availability deficit of at least 300 MHz). Also see Bazelon, C and McHenry, G, 'Substantial Licensed Spectrum Deficit (2015–2019): Updating the FCC's Mobile Data Demand Projections' (Brattle Group 23 June 2015) (estimating the deficit as of 2019 at 366 MHz with two thirds unmet by interim re/allocations of licensed spectrum as of 2016), <http://files.brattle.com/files/5927_substantial_licensed_spectrum_deficit_(2015-2019)_-_updating_the_fcc's_mobile_data_demand_projections.pdf>.

[7] One estimate is that in 2035, 5G value chain will globally have USD 3.5 trillion in output and support 22 million jobs. 'How 5G Technology Will Contribute to the Global Economy' (Communications Today, April 2017) (based on Qualcomm Report), <http://www.communicationstoday.co.in/reports/10255-how-5g-technology-will-contribute-to-the-global-economy>.

[8] See FCC Staff Technical Paper, n 6. Also, see Decision 243/2012/EU of the European Parliament and of the Council establishing a multi-annual radio spectrum policy programme (RSPP Decision), OJ L 81/7, 14 March 2012; Decision 676/2002/EC of the European Parliament and of the Council on a regulatory framework for radio spectrum policy in the European Community (Radio Spectrum Decision), OJ L 108/1, 7 March 2002.

[9] Hazlett, TW, 'FCC "Incentive Auction" marks progress and pitfalls toward freeing wireless spectrum' (The Brookings Institute, 24 May 2017).

[10] In Europe, the bandwidth freed comprised 470–862 MHz or the UHF band which has long wave coverage with building penetrating capabilities suitable for mobile networks.

by the new LTE 4G signals in the 800 MHz band of which 900,000 UK households with only Freeview likely to lose all or part of this Digital Terrestrial Television (DTT) service.[11] Although this estimate has likely proved well beyond actual experience to date, the possible problems could not be ignored.[12] The government determined that the spectrum winners establish a private entity, Digital Mobile Spectrum Limited, (pursuant to an imposed licence condition and key performance indicators) with a budget of up £180 million (added to the spectrum licence fees) to manage these problems. It has an oversight board of mobile operators and broadcasters, several independent board members as well as Ofcom and the Ministry of Digital, Culture, Media & Sport. This entity, aka 'at800', appears to be addressing most problems by sending and/or installing filters for the interfering bandwidths,[13] although not all homes are projected to be able to use this fix with some possibly requiring a new platform for which a payment of up to £10,000 was authorized.[14] The company is also now beginning to address issues arising from the UK clearance of DTT from the 700 MHz band for mobile data use that Ofcom has indicated it is accelerating by eighteen months to 2020.[15]

The need to free harmonized bands of spectrum for wireless broadband also drove the repurposing of spectrum bands to allow 3G and then 4G in bands originally allocated for 2G, the earlier generation of digital communications, comprising eg in the EU, the 900/1800 MHz bands.[16] This involves technical co-existence in parts of the bands over which 2G services are still provided (and possibly will

[11] See Ofcom, Second Consultation on coexistence of new services in the 800 MHz band with digital terrestrial television (23 February 2012), <http://stakeholders.ofcom.org.uk/binaries/consultations/949731/summary/condoc.pdf>.

[12] Although the 'actual' numbers do not reflect the nearly 1 million filters sent out in advance proactively by at800 and not in response to a complaint. See Letter from Chair 4G/TV Coexistence Oversight Board to Ofcom proposing revised scheme and trial (Dept for Culture, Media & Sport, 18 December 2013) (requesting enforcement forbearance for a pilot to explore varying the licence conditions and KPIs of 4G spectrum winners in their operation of at800 to permit greater flexibility in light of experience to date and much lower actual numbers of involved households with a view to permanent variance, if successful).

[13] See eg, Matthews, C, 'New 4G masts in Camborne could cause interference for Freeview users' (Cornwall.live, 7 March 2018), <https://www.cornwalllive.com/news/cornwall-news/new-4g-masts-camborne-could-1308423>. Not all households have been fully compensated or their problems proactively addressed by at800 as new 4G masts become operational. See Corr, S, 'Cookstown residents out of pocket as 4G signal kills Freeview TV' (Mid-Ulster Mail, 18 December 2015) (noting that couple in their 80s only offered £50 reimbursement of £105 spend to fix interference problem, notification of which they did not receive), <https://www.midulstermail.co.uk/news/cookstown-residents-out-of-pocket-as-4g-signal-kills-freeview-tv-1-7121102>.

[14] Department for Culture, Media and Sport, News Release, 'Eliminating Interference with TV signals from 4G', 2 April 2012, <http://www.culture.gov.uk/news/media_releases/8865.aspx>.

[15] Ofcom, 'Statement: Maximising the benefits of 700 MHz clearance, Enabling acceleration of 700 MHz clearance and use of the 700 MHz centre gap', 10 October 2016.

[16] See eg Commission Decision 2011/251/EU amending Decision 2009/766/EC on the harmonization of the 900 MHz and 1800 MHz frequency bands for terrestrial systems capable of providing pan-European electronic communications services in the Community, [2011] OJL 106/9, 18 April 2011.

continue to be as more advanced mobile handsets still have this capability and these bands allow for other uses such as existing machine-to-machine systems that would require costly upgrades).[17] Mitigation of adverse effects has been addressed via mandatory channels where technically necessary[18] as well as cooperation among providers. Regulatory policy in refarming also often needs to address compensatory issues where the refarming constitutes a taking by government or where existing equipment is no longer usable.[19] The US voluntary incentive auction was an innovative way to do this although it did not achieve the targeted 120 MHz of returned spectrum, with only 70 MHz procured for reallocation.[20]

Concerns about competitive disadvantage may arise from refarming. For example with 2G spectrum, these could include that it was obtained under different allocation processes and at lower costs than that incurred for 3G and most recently, 4G. When the EU directed that 2G bands be liberalized,[21] rather than reauction them, the UK government sought to address these concerns by directing that Ofcom allow current spectrum incumbents to retain the 2G bands of 900/1800 MHz they were allocated in the 1980s but pay current full market value for their liberalized use.[22] Ofcom set the market value prices using benchmarks such as the 2013 UK 4G spectrum auction results and other markets' 2G refarming auction prices but converted to annual fees (as these 2G were never auctioned) and further adjusted, by taking into account the delay in the spectrum's availability. Ofcom ultimately raised the fees by nearly quadruple their original amount. The incumbents appealed. The Court of Appeal struck down Ofcom's pricing decision that was originally upheld by the High Court as will be discussed further.[23]

Other competitive concerns arise since 2G spectrum was likely to be held by the original mobile market entrants, often a duopoly. Allowing them to change

[17] Chambers, D, 'The mobile industry focuses on spectrum refarming through 2017' (ThinkSmallCell, 2 February 2017), <https://www.thinksmallcell.com/Technology/the-mobile-industry-focuses-on-spectrum-refarming-throughout-2017.html>.

[18] See eg Commission Decision 2009/766/EC on the harmonisation of the 900 MHz and 1800 MHz frequency bands for terrestrial systems capable of providing pan-European electronic communications services in the Community (in allowing for the use of these 2G bands spectrum by UMTS terrestrial systems, requiring separation channels for neighbouring UMTS systems of 5MHz and neighbouring GMS and UMTs systems of at least 2.8 MHz), OJ L 274/32, 16 October 2009.

[19] See Ofcom Statement, 'Maximising the benefits of 700 MHz clearance, Enabling acceleration of 700 MHz clearance and use of the 700 MHz centre gap', 10 October 2016 (noting that the UK government will fund a grant in 2019 for programme-making and special events (PMSE) users whose equipment will no longer be operational when the 700 MHz band is cleared before the expected date).

[20] See Hazlett, n 9.

[21] Decision 243/2012/EU of the European Parliament and of the Council establishing a multiannual radio spectrum policy programme, [2012] OJ L 81/7, 21 March 2012.

[22] The Wireless Telegraphy Act 2006 (Directions to OFCOM) Order 2010, SI 2010/3024.

[23] Decision 243/2012/EU, n 21.

their licences to include its use for 4G could provide their earlier ability to move to the new technology if liberalized before other 4G spectrum is auctioned or at a lower cost than other 4G spectrum. Such time and cost advantages could serve to entrench the market position of these earliest mobile market entrants. A UK tribunal interpretation of the EU 'Refarming Directive',[24] however, found that the original 2G GSM spectrum grantee had no directly enforceable right to the automatic revocation of any restrictions in its 2G licence to enable 3G use with only *ex post* competition law to address any anti-competitive effects, a compulsory EU regulatory objective.[25] Rather, the Directive required a technical harmonization to be effected by making the bands 'available' for 3G use (although unnecessary in the UK) with specific authorization decisions to follow after the mandatory framework consultation and taking into account on an *ex ante* basis any distortions in competition.[26]

Another key issue with refarming is that significant amounts of spectrum is allocated for public sector purposes, eg in the EU noted to comprise up to 40–50 per cent of usable frequencies below 15 GHz.[27] For some uses this may not only need to be repurposed at the national level but also require regional and international harmonization for effective cross-border use such as for mobile networks.[28] In the UK, for example, since 2010 various public agencies have identified bands that could be freed up or shared with new uses under the Public Sector Spectrum Release Programme's goal to free up 500 MHz of bandwidth from public uses. According to the government, this has been 80 per cent achieved. The Ministry of Defence, for example, released 200 MHz of bandwidth in the 2.3 GHz–2.4 GHz and 3.4 GHz–3.6 GHz bands that was to be made available by 2016 for public mobile uses including likely 5G in the 3.4GHz bands. This spectrum auction, however, was delayed until April 2018 by legal challenges to Ofcom's proposed caps on the amount of spectrum that any one holder might control. These were to address competition concerns in light of BT's acquisition of EE that gave it the largest share of available spectrum at 45 per cent, although not market share as BT had not provided mobile services since its 2006 sale of O2 to Telefónica.[29] As noted, the US similarly

[24] Directive 2009/114/EC amending Directive 87/372/EEC on the frequency bands to be reserved for the coordinated introduction of public pan-European cellular digital land-based mobile communications in the Community.

[25] See *Telefonica O2 Ltd v Ofcom* [2010] CAT 25. [26] Ibid, at 85, 90–102.

[27] Commission Discussion Paper EU Spectrum Summit, at 6 (22–23 March 2010).

[28] See eg UK Dept for Culture, Media and Sport, 'Enabling UK Growth: Releasing Public Spectrum Update on Progress', December 2011 (noting mobile network operators' preference for spectrum harmonized at the international level over spectrum that was not).

[29] Torrance, J, 'Ofcom accuses Three of holding up spectrum auction after failed legal bid' (The Telegraph, 20 December 2017), <http://www.telegraph.co.uk/business/2017/12/20/ofcom-accuses-three-holding-spectrum-auction-failed-legal-bid/>.

committed to repurposing at least 500 MHz of bandwidth from both federal government agencies and private entities for mobile and fixed broadband uses. As of 2015 over half had been made available.[30] The US auctions addressed competition concerns via 'set asides' for entities with sparse holdings of spectrum below 1 GHz, overall caps of the amount to be auctioned and a cap for a single entity serving sparsely populated areas.[31] The EU in its newly adopted Multi-Annual Spectrum Policy Programme clearly contemplates a harmonized approach across the EU to repurposing public sector spectrum.[32]

A regulatory option for making spectrum more broadly available is the deregulation of spectrum frameworks from existing 'command and control' models that dictate use according to the technical characteristics of the spectrum, explored briefly in Section 7.2, to allow a market-driven determination of best use and continued innovation and as well, economically efficient pricing, and essentially service and technological neutrality. The concern here is how to ensure non-interference and safe use that the designated allocation was intended to control in the first place.

Finally, spectrum licensing liberalization may enable those with grants of spectrum to participate in secondary spectrum markets enabling under-utilized spectrum to be shared or used exclusively by others but more efficiently.

A full exploration of all these issues is beyond the scope of this chapter which intends to provide an overview of spectrum used for communications and its regulation, historically and today, so that the reader will appreciate the differences from telecommunications licensing generally addressed in the prior chapter. To do this, it first considers at a fairly basic level the nature and characteristics of spectrum used in communications with inherent relevance to spectrum regulation. It then provides an overview of historical spectrum regulation including at the international level and national level generally for a sense of how and why the frameworks are what they are. It will then examine the EU framework which seeks to harmonize Member State approaches to spectrum regulation, generally within national competence, in order to foster the continued economic and social development of the Single Market. National policy priorities could undermine this given that spectrum interference does not respect national boundaries and mobile communications are a significant growth sector and emergent platform for new

[30] Priztger, P and Strickling, L, 'Six Interim Progress Report on the Ten-Year Plan and Timetable' (Dept of Commerce, June 2016). Also see, FCC Staff Technical Paper, n 6, at 2.

[31] Meyer, D, 'FCC sets aside 30 megahertz for auction set to begin March 29, 2016' (RCR Wireless News, 6 August 2015), <https://www.rcrwireless.com/20150806/policy/fcc-releases-600-mhz-auction-rules-stomps-t-mobile-increased-reserve-request-tag2>.

[32] Decision 243/2012/EU of the European Parliament and of the Council establishing a multiannual radio spectrum policy programme, [2012] OJ L81/7, 21 March 2012.

commercial and government services. The chapter will also examine some recent reforms by the EU to drive this harmonization. It will finally examine how the UK has implemented the EU framework, an overlay on its own legislative scheme that has been in place since the mid-1800s.

7.2 SPECTRUM AND COMMUNICATIONS

All radio spectrum comprises waves of electromagnetic energy (photons) that are measured in terms of their frequency,[33] or how many times the wave repeats in a second of time, a cycle counted in 'Hertz'.[34] Thus a wave that repeats once in a second has a frequency of 1 Hz, a thousand times a second, 1 kilohertz (kHz), a million times a second, 1 megahertz (MHz), a billion times a second 1 gigahertz (GHz). The portion of electromagnetic spectrum usable for communications/transmission technologies has increased over time with technological developments.[35] Lowest usable frequency is likely now at 8.7 kHz (very low frequency or VLF) with recent developments in weak signal processing software[36] and the highest presently around 300 GHz, although the entire range of what is considered 'radio spectrum' consists of frequencies between 3 kHz and 3000 GHz.[37]

There is a mathematical correspondence with frequency and length and, length and distance.[38] Lower frequency waves are longer, travel further, and penetrate structures better without attenuation. Thus, lower frequencies have traditionally been valuable in broadcasting. Higher frequency waves are smaller and do not travel as far.[39] Thus, while not suitable for broadcast, these can be re-used across

[33] Electromagnetic spectrum can also be measured according to the length of the wave and its energy with the three elements having a mathematical relationship, so that low frequency waves are long with low energy or power and high frequency waves are very short and have high energy. See Imagine, 'Electromagnetic Spectrum: Introduction' (NASA GSFC, February 2010), <http://imagine.gsfc.nasa.gov/docs/science/know_l1/emspectrum.html>.

[34] Usually measured from the highest point of one wave to the same point in the next, although a standard without a technical difference as the measure of repetition will be the same no matter what point is used.

[35] See Lapthorn, R, 'Sub-9kHz Amateur Radio' (March 2011) (noting sub-9 kHz range radio communications an impossibility as little as five years ago), <https://sites.google.com/site/sub9khz/>.

[36] See ibid.

[37] See eg Rysavy, P, 'Low Versus High Radio Spectrum' (High Tech Forum, 5 March 2012), < http://hightechforum.org/low-versus-high-radio-spectrum/>.

[38] There is also correspondence between these and a wave's height, called 'amplitude'. See Imagine, 'Electromagnetic Spectrum: Introduction' (NASA GSFC, February 2010), <http://imagine.gsfc.nasa.gov/docs/science/know_l1/emspectrum.html>.

[39] The power of the transmitting device is also relevant to distance that radio waves can travel.

geographic areas and can carry more data.[40] As basically illustrated in Table 7.1, different frequencies' propagation characteristics are relevant to different communication uses and technologies. While waves at the same frequency in the

Table 7.1 ITU radio frequency designations

	Designation	Frequency Range	Wavelengths	Typical Uses
ELF	Extremely low frequency	3 Hz to 30 Hz	100 Mm to 10 Mm	Submarine communications
SLF	Superlow frequency	30 Hz to 300 Hz	10,000 km to 1,000 km	Submarine communications
ULF	Ultralow frequency	300 Hz to 3 kHz	1,000 km to 100 km	Mine communications
VLF	Very low frequency	3 kHz to 30 kHz	100 km to 10 km	Submarine communications, avalanche beacons, wireless heart monitors, geophysics
LF	Low frequency	30 kHz to 300 kHz	10 km to 1 km	Navigation, time signals, AM broadcasting
MF	Medium frequency	300 kHz to 3 MHz	1 km to 100 m	AM (medium wave) broadcasting
HF	High frequency	3 MHz to 30 MHz	100 m to 10 m	Short wave broadcasting, amateur radio, long range aviation and military communications
VHF	Very high frequency	30 MHz to 300 MHz	10 m to 1 m	FM broadcasting, television, ground-to-air and air-to-air communications
UHF	Ultrahigh frequency	300 MHz to 3 GHz	1 m to 10 cm	Television, mobile phones, wireless LAN, Bluetooth, microwave ovens
SHF	Superhigh frequency	3 GHz to 30 GHz	10 cm to 1 cm	Wireless LAN, radar
EHF	Extremely high frequency	30 GHz to 300 GHz	1 cm to 1 mm	Radio astronomy, high-speed microwave radio

[40] Rysavy, n 37.

same space can interfere with each other, waves at different frequencies do not. Filters and smart antennas can eliminate those that are not wanted, leaving the receiver to decode the information carried as energy without mass on the wave. Radio waves comprising photon energy travel at the speed of light and can often travel through non-conductive materials without being absorbed,[41] also relevant to various wireless communications uses.

7.3 CHART OF RADIO SPECTRUM

That different frequency characteristics make certain uses more likely, combined with the fact that radio waves don't stop at international borders and the possibility of interference with simultaneous but competing uses at the same frequency in the same geographical location led to national, international, and multilateral cooperation in spectrum policy and allocation management, notably via a framework established within the International Telecommunication Union (ITU), perhaps the oldest intergovernmental body. Coordination of frequency has also had the benefit of allowing the manufacture of equipment that can operate cross-borders and, optimally, internationally, with ensuing economies of scope.

International spectrum 'regulation' also comes from the World Trade Organization to the extent that the General Agreement on Trade in Services (GATS) and the Reference Paper impose transparency and other obligations regarding spectrum licensing, as well as from international standards bodies like the Institute of Electrical and Electronics Engineers (IEEE) that work to develop technical specifications for radio equipment. One example is the 802.11 wireless local access network family of standards that permit multiple non-interfering uses within ITU bands, requiring limited regulatory oversight.[42] Although important, a discussion of these sources of spectrum regulation is also beyond the scope of this chapter.[43]

[41] This, as noted, is a very basic analysis. There are many things that affect the propagation characteristics of radio waves at various frequencies, including weather, the earth's curvature and topography, the ionosphere, line of sight reception, solar flares, absorbing (eg water) and reflective (the ground) or diffractive (roof edges) surfaces. These of course depend on the frequency/wave length involved. For a good overview of wave propagation, see Toronto Emergency Communications Group, 'Basic Amateur Emergency Radio Course: Module 7: Radio Wave Propagation', October 2010, <http://www.emergencyradio.ca/course/>.

[42] The WiFi 802.11 is a grouping of IEEE standards for low-powered high frequency communications systems intended for non-interfering use within the International Telecommunication Union (ITU) Industrial, Scientific, Medical bands designated by ITU-R in 5.138, 5.150, and 5.280, Radio Regulations. Use of WiFi is often unlicensed or exempt or subject only to interference tolerance requirements. See generally, eg Negus, K and Petrick, T, 'History of Wireless Local Area Networks (WLANS) in the Unlicensed Bands', (2009) 11(5) Journal of Policy, Regulation and Strategy for Telecommunications, Information and Media 36.

[43] But see Chapter 16, at Section 16.4.

The following section examines the history of spectrum regulation which is helpful to understanding the modern regulatory framework.

7.4 HISTORY OF SPECTRUM REGULATION

As with other elements of telecommunications, the use of radio spectrum and its regulation at the national and international levels arises from the footprint of earlier technology: wired telegraphy and telephony.

7.4.1 International regulation of telegraphy

The mid-1800s saw the emergence and proliferation of national electrical telegraph networks enabling almost instantaneous communications. However, each country had its own systems with the result that messages would have to be transcribed and translated and transported across to the other national system operators to be retransmitted in that country. The telegraph was the most significant invention in communications history, transforming for the first time the speed of message delivery. For thousands of years, this had remained unchanged: the distance a man could travel on horse, or about 100 miles a day.[44] To exploit this potential speed, countries recognized that they needed to enable cross-border telecommunications and began to develop bilateral and regional agreements harmonizing codes and costs and standardizing equipment.[45] However, they soon viewed a unifying multilateral treaty as necessary in a shrinking world thanks to steam engines for ships and railroads. In 1865, twenty nations met in Paris to develop an international communications framework. This resulted in the International Telegraph Convention and Regulations[46] which created the International Telegraph Union (ITU) to regulate subsequent changes to the Convention.[47] This regulatory international framework and institution was the natural forum for other international cooperation and harmonization that arose with the further two revolutions in communications technology of the nineteenth century: the telephone and wireless telegraphy, the forerunner of other wireless communications technologies.

[44] Standage, T, *The Victorian Internet* (New York Walker & Co, 1998), 2.

[45] Schmahl, S, 'The United Nations: Facing the Challenges of the "Information Society"', (2007) 11 Max Planck UNYB 197, 210.

[46] Convention télégraphique internationale de Paris (1865) et Règlement de service international (Paris, 1865), CTS Vol 130 No 198.

[47] See Feyman, RP, et al, 'Electromagnetic Radiation', The Feyman Lectures on Physics, Vol 1 (CalTech, 1971), 28–1.

Wireless telegraphy, like many other technologies, evolved from a series of theoretical and practical advances over time. Marconi is largely credited with 'inventing' wireless telegraphy in the late 1890s. While the extraordinary achievement of his experimentation to apply theory and produce workable equipment as well as his efforts to commercialize wireless technology cannot be minimized, Marconi was standing on the shoulders of giants, as the expression goes. These include, among others, James Clerk Maxwell, a Scottish physicist and mathematician, who in 1865 formalized a cohesive electromagnetic wave propagation theory underpinned by his mathematical equations and which organized prior disparate theories, experiments, and practical observations about light, electricity, and magnetism.[48] Heinrich Hertz proved Maxwell's electromagnetic wave theory by constructing an apparatus detecting their presence. In 1895, inspired by Hertz's discovery, Marconi began experimenting with Hertzian waves, attempting to transmit signs and symbols without connecting wires.[49] In 1895, he successfully transmitted a signal a distance of 2km.[50] As Italy lacked interest in his experiments, Marconi moved to England at the Post Office's invitation[51] where he continued his experiments. In 1896 he was granted a patent in his invention and started the Marconi Wireless Telegraphy Co, to develop his worldwide patent monopoly and commercialize the invention fully via equipment manufacture and the construction of wireless telegraphy networks.[52] His continued experimentation progressively extended the distance over which the signals were conveyed until 1901 when he successfully transmitted a message from southwestern England to Newfoundland, a distance of 2100 miles[53] and in early 1902, between a wireless telegraph station in Cornwall, England and the SS Philadelphia, an American ship.[54]

Marconi realized that transmission of readable messages over long distances had major implications for maritime safety and naval operations, having conducted a range of experiments with the British Navy.[55] In 1898, the Marconi Wireless

[48] They also include Michael Faraday on which Maxwell's work expanded. See Biography: Michael Faraday, Institution of Engineering and Technology, <http://www.theiet.org/resources/library/archives/biographies/faraday.cfm>.

[49] Marconi, G, 'Wireless Telegraphic Communication: Nobel Lecture 1909', <http://www.nobelprize.org/nobel_prizes/physics/laureates/1909/marconi-lecture.pdf.>.

[50] Braga, GM, 'Marconi Family History' (Marconi Family Society), <http://marconisociety.org/about/marconi-family/>.

[51] Events in Telecommunications History, BT Archives, <http://www.btplc.com/Thegroup/BTsHistory/1881to1911/1896.htm>.

[52] Marconi, n 49. [53] Ibid.

[54] According to Marconi who was onboard the SS Philadelphia, 'readable messages were received by means of a recording instrument up to a distance of 1,551 miles and test letters as far as 2,099 miles from Poldhu.' Marconi, n 49.

[55] For example, in 1899, on two separate occasions when the East Goodwin Sands Lightship encountered problems at sea, lives were saved because the vessel had been equipped with radio installation and could send distress messages, allowing assistance to be quickly dispatched, see Howeth, LS, (Capt., USN (Retired), 'Birth

Telegraph Co entered into an agreement with marine underwriters at Lloyd's to install radio systems at some of their signal stations.[56] In 1900, the Marconi International Marine Communication Co contracted with Lloyd's to install a series of radio stations along England's coasts using only Marconi equipment and prohibiting Lloyd's station operators from communicating with ships using radio equipment not Marconi manufactured.[57] Underwriters also agreed that ships insured by Lloyd's would exclusively use Marconi's equipment and could not communicate with other vessels or shore stations using other companies' equipment.[58] The contract was for fourteen years, the duration of Marconi's patent.[59]

7.4.2 The emergence of international radio communications regulation

Marconi's attempt to leverage the patent into a monopoly on radio communication caused international alarm.[60] Perhaps in addition to the competition concerns apparently heightened by a sense of injustice that Marconi could exercise this to the disadvantage of others when he alone benefited among the many great scientists from numerous countries whose intellectual contribution enabled Marconi's antenna,[61] was that his exclusionary conduct flew in the face of maritime tradition of rendering assistance to ships in peril without regard for compensation.[62] In response, nine ITU member states, the US, Germany, Russia, France, Austria, Hungary, Italy, Great Britain, and Spain, held a preliminary conference in Berlin in 1903 addressing the need for international regulations for radiograph communication and drafted a protocol to that end.[63] This sought to address stated concerns that Marconi's monopoly would limit the usefulness of radio telegraphy and impede further technological development still necessary for solutions to problems

of Science of Radio and Development of Usable Components' History of Communications-Electronics in the United States Navy (Bureau of Ships and Office of Naval History, 1963), Section 9: 'First Uses of Radio as an Aid to Safety of Life at Sea', <http://earlyradiohistory.us/1963hw02.htm#2footnote>.

[56] Ibid, Section 10. [57] Ibid. [58] Ibid. [59] Ibid.

[60] Radiotelegraph and Radiocommunications Conferences, 'Preliminary Conference on Wireless Telegraphy (Berlin 1903)' (ITU History Portal), available at: <https://www.itu.int/en/history/Pages/RadioConferences.aspx?conf=4.35>.

[61] See Kraetke, 'Opening Speech', Minutes, Procés-Verbaux and Protocole Finale, Preliminary Conference on Wireless Technology (Berlin 1903) (trans Neilson, GR), 5, <https://www.itu.int/dms_pub/itu-s/oth/02/01/S02010000284803PDFE.pdf>.

[62] This surmise is not impossible given the then state of German cartelization, see McGowan, L, *The Antitrust Revolution in Europe*, (Cheltenham: E. Elgar, 2010), 50–52 and the fact that this principle was formalized into international law only seven years later in the Convention for the Unification of Certain Rules of Law Relating to Assistance and Salvage at Sea of 1910 (Brussels Convention). See Parent, J, 'No Duty to Save Lives, No Reward for Rescue: Is that Truly the Current State of International Salvage Law?', (2006) 12(1) Annual Survey of International & Comparative Law 90–92, < https://digitalcommons.law.ggu.edu/annlsurvey/vol12/iss1/6/>.

[63] Minutes, Berlin Preliminary Conference, n 61, at 3–4.

such as interference and that radio telegraphy needed to be promoted internationally.[64] Specifically, the protocol agreed that coast stations were to receive and transmit telegrams to and from ships without distinction to the wireless system used by the ships and that 'working wireless telegraph stations must be organized, as far as possible, in such a manner as not to interfere with the working of other stations'.[65] This first set of wireless regulations would serve as the model for future regulation.

In 1906, the first International Radiotelegraph Conference was held with thirty countries participating.[66] They adopted the first International Radiotelegraph Convention which established compulsory intercommunication between ships and shore stations, regardless of the system used[67] in a final protocol similar to those drafted in 1903.[68] This protocol, however, also created the first international Table of Frequency Allocations with frequencies from 500 to 1000 kHz allocated for public use in the maritime service, frequency bands below 188 kHz assigned for long-distance communication by coast stations, and another band, 188–500 kHz, identified for military and naval stations not open to public use.[69] The conference also gave priority to the Morse Code SOS distress signal (… --- …).[70] The Convention entered into force in 1908,[71] marking the beginning of international regulation of radio communication and spectrum allocation and standards harmonization.

To table frequencies, members notified the Union of their existing and planned uses which were entered into a register. As has been noted, these early processes had later consequences. The act of registration gave the user 'squatter's right' to that spectrum and once a usage was recognized, it had international law imprimatur.[72]

[64] Ibid.

[65] ITU Library and Archives, 'Art V, Final Protocol – Preliminary Conference on Wireless Telegraphy (Berlin 1903)', <https://www.itu.int/en/history/Pages/RadioConferences.aspx?conf=4.35>.

[66] Conference Documents, Procés-Verbaux, Conférence Internationale Concernant La Télégraphie Sans Fil (German Department of Post, Empire, 3 October 1906 Berlin), 39–43, ITU Radiocommunication Conferences, <http://www.handle.itu.int/11.1004/020.1000/4.36>.

[67] See Radiocommunications Sector, '100 Years of ITU Radio Regulations (1906–2006)', <https://www.itu.int/en/history/Pages/100YearsITURadioRegulations.aspx>.

[68] These have since been expanded and revised by numerous radio conferences, and are now known as the Radio Regulations. They are part of the Administrative Regulations and the legal basic framework of the ITU with treaty status. During the 1906 Convention, the protocol was only twelve pages long. The Radio Regulations, now 122 years old, generally harmonizing how frequency spectrum may be used and shared among various services, comprise over 2300 pages. See ITU History Portal: Radio Regulations—An Introduction (ITU 2008), <http://itu150.org/historical-timeline/>. See also Chapter 16, at Section 16.3.

[69] Timofeev, V, 'How ITU processes and regulations have helped shape the modern world of radiocommunications', (*ITU News Magazine*, 2006) 5–9, <http://search.itu.int/history/HistoryDigitalCollectionDocLibrary/12.26.71.en.pdf>.

[70] Ibid. [71] Ibid.

[72] See eg McPhail, TL, 'The Medium: Global Technologies and Organizations', in *Global Communications: Theories, Stakeholders, and Trends* (Wiley-Blackwell, 2011), 270–271.

Subsequent interfering uses were prohibited with the result that 'first-come, first served' became the operational norm with most spectrum allocated to certain North American and European nations.[73] The issue was not divisive when the primary allocations were for maritime activity but with the emergence of commercial broadcast and other public radio this became a growing problem. In 1929, there was agreement for further formal coordination by allocating bands or groups of bands for specific services.

In 1932, the International Telegraph Union and the International Radiotelegraph Conference merged into the International Telecommunication Union. Its workings continue to this day via ITU-R.[74] Other technical standards were added. A table of tolerances and another giving the acceptable bandwidths for various types of emissions were added into the regulations[75] as guides for national administrations to measure the technical conformity/efficiency of radio stations and to focus their attention on the need to develop effective controls on transmitting stations.[76] To combat harmful interference and ensure that countries followed the harmonized allocated radio bands that evolved over time with new discoveries such as short waves, registration requirements were strengthened. These require countries to inform the ITU prior to using a new frequency and/or changing the power of a frequency already in use.[77]

In 1947, the ITU became a specialist agency of the United Nations. At that year's International Radio Conference, the International Frequency Registration Board was created. Its role was to formalize, administer, and oversee a master frequency register to track notifications and usage and ensure the compliance of a new frequency use registered with the requirements of the Radio Regulations. This work in connection with international coordination of spectrum, allocation, and interference control is accomplished via the ITU-R. Its Recommendations address technological developments that may, inter alia, enable new uses, enhance capabilities, and address the desirability of old uses.[78] These can be adopted as binding Radio Regulations at ITU Radiocommunication Conferences. Starting in 1947, the ITU divided the world into three regions for the coordination and registration as well as for the preparatory work for its Radio Conferences and regulation promulgation. This allows for regional variation where international harmonization is not

[73] Ibid. [74] See Chapter 16, at Section 16.3. [75] Ibid.

[76] '50th Anniversary of the Madrid Conferences', (1982) 49(9) Telecommunication Journal 510–511, <https://itu.tind.io/record/13682?ln=en>.

[77] Ibid.

[78] It is noted that sometimes allocations are determined purely on technological and not political considerations. For example, spark gap wireless technology used in ship transmitters was simple to use but wasteful of spectrum and with considerable signal interference. It was just phased out of usage over time. See Krasner, SD, 'Global Communications and National Power: Life on the Pareto Frontier', (1991) 43(3) World Politics 351.

essential or based only on technical merits and permits a structure to help consensus building, not an easy process with so many different interests.[79] The division comprises: Zone 1, Europe, Africa, the Middle East; Zone 2, the Americas; and Zone 3, Australia, China, Japan, and other Asian countries.

The ITU international coordination process of allocating bands and promulgating harmonizing recommendations and regulations for efficient and non-interfering uses of radio spectrum continues to this day. The process has not been without criticisms, such as the ITU's failure to intervene until congestion and interference had already occurred, and to allocate only according to present needs and technological capability to the detriment of developing nations.[80] The continuity of purpose and process of this oldest claimed intergovernmental organization, however, remains notable. For example, the most recent World Radio Communications Conference took place in November 2015 and the next will be in 2019. On its agenda is regulatory support of Global Marine Distress Safety Systems' modernization, including evaluation of how adding other satellite systems, eg mobile satellite systems, can be supported as per Resolution 359 (rev.WRC-15), allocations and how possible modifications of the Regulations impact compatibility and sharing with other services,[81] an issue blending the regulatory and technical concerns of efficient spectrum management with systems begun over 100 years ago.

7.4.3 National spectrum frameworks and the ITU

The ITU allocation framework is the product of international consensus and is generally enforced by the good will and cooperation of the member states that produced it under principles of international treaty obligation.[82] A key component of coordination and enforcement, therefore, is the corresponding framework at the national level. In the EU there is also harmonization, with EU institutions working to coordinate spectrum according to ITU regulations.[83] This, however, entails a

[79] Ibid, considering an economic analysis of pareto outcomes to the international spectrum allocation framework which, post-1971, is noted to be different from that based solely on equal need for coordination that existed previously.

[80] See McPhail, n 72. These issues are considered further in Chapter 16.

[81] See WRC 2019 Agenda Item Details, Agenda Item 1.8, (Transfinite Systems), <https://www.transfinite.com/content/wrc2019list>.

[82] As has been noted, 'The ITU is really a gentlemen's club. It depends on the goodwill of its members. There is no mechanism for forcing an administration into compliance with the rules', de Selding, PB, 'France seeks ITU help to Halt Satellite Signal Jamming by Iran' (Space News, 1 August 2010) (quoting Francois Rancy, director of France National Frequencies Agency), <http://spacenews.com/france-seeks-itu-help-halt-satellite-signal-jamming-iran/>.

[83] See ERC Report 25, 'European Table of Frequency Allocations and Applications in the Frequency Range 8.3 kHz to 3000 GHz (ECA Table)' (CEPT 2017) (noting its 2002 principle of adopting a 'harmonised European Table of Frequency Allocations and Applications to establish a strategic framework for the utilisation of the radio spectrum in Europe'), <http://www.erodocdb.dk/docs/doc98/official/pdf/ercrep025.pdf>.

complex arrangement of competences with the EU Member States which as sovereign states and ITU members themselves have jurisdiction over national spectrum allocation but which are bound to exercise these rights in compliance with EU law. This is an area where the EU has asserted its view of the clear limits on any Member State international obligation at the ITU or bilateral level that is not qualified by existing EU Treaty limitations, comprising another application of the 'existence versus exercise' distinction that has been found to rationalize EU supremacy in other areas of seemingly exclusive residual national competence.[84]

Considering national approaches to regulating radio spectrum, it can be said that these were essentially similar around the world for over 100 years. Ofcom noted the limitations in its 2004 Spectrum Framework Review:

> The general approach adopted world-wide during this period has been for the spectrum manager to decide on both the use of a particular band and which users are allowed to transmit in the band. This approach was appropriate when much spectrum was used by the Government for purposes such as defence, public safety, aeronautical and maritime communications and broadcasting. While there were relatively few uses and users, the spectrum manager could also reasonably have as good an understanding of the best use of spectrum as the market itself and hence could sensibly control all aspects of spectrum usage.[85]

These uses would be reflected in a national allocation table identifying the services for which specific allocated bands could be used and which likely encompassed the international allocation obligations. Allocations and controls have until fairly recently largely been effected via command and control administrative processes using the tool of licensing as a means to specify usage rights, including term, service, geographic area, configuration, apparatus, etc,[86] and conditions for that use that could include payment of an annual fee, power limitations, and requirements for conformity to what in the EU are called 'essential requirements' for such things as electromagnetic compatibility and efficient spectrum use so as to prevent interfering operation of relevant radio spectrum.[87]

With the competing commercial demands for its use, nations began to seek ways to allocate fairly the spectrum among the many applicants. The US first used a comparative process to assign licences for various cellular wireless services to

[84] This is the case with intellectual property rights, see Case 16-74, *Centrafarm v Winthrop* [1974] ECR 1183; Case 15-74, *Centrafarm v Sterling Drug* [1974] ECR 1147.

[85] Ofcom, 'Spectrum Framework Review', 2004.

[86] See eg Australian Cordless Class Licence 2014, <https://www.legislation.gov.au/Details/F2014L01800>.

[87] See recitals 4–8, Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC, [2014] OJL 153/62, 22 May 2014.

which it had allocated frequency. It set what it considered were appropriate standards for awarding the available, free licences according to the FCC's statutory charge of 'public interest, convenience and necessity'.[88] The licences were awarded to the candidate considered most qualified after hearings, with decisions often appealed for years in the US courts. The comparative processes, labelled 'beauty contests', were time and resource consuming for both applicants and the FCC. They were criticized as too slow, costly, and serving as an impediment to new service entry.[89] Also, questions raised about comparative processes concerned the objectivity of their selection criteria and their transparency. The US then employed lotteries to address these concerns. Pre-lottery screening, however, to ensure that only qualified applicants participated in the lottery was similarly time and resource intensive with screening for the first lottery lasting twenty months with the same concerns about the pre-selection criteria.[90] Open lotteries followed. These, however, introduced speculation and ensuing windfall profits for applicants who had won licences with no intention of providing service to the public and who quickly traded them on then emergent secondary markets. The additional time inherent in a second transaction and the process to reassign the licence as well as the necessity to aggregate licences necessary to use the spectrum efficiently were also suboptimal and delayed service roll-out.[91]

The US in 1993 authorized a market mechanism for spectrum allocation, competitive bidding. This decision was premised on modern economic theory that efficient use of scarce resources such as spectrum required allocation other than via traditional command and control since these mechanisms would ensure that the spectrum went to those who valued it the most and would ensure its most productive use.[92] While these can be structured in different ways, the US, the UK, and many other countries now employ a form of auction where price alone, typically, dictates outcome. Other criteria or limitations can apply for participation to further social or competition policy, such as set asides to permit new entrants or spectrum caps to ensure relative competitive holdings of spectrum.[93] While pure price auctions may be more objective than comparative processes, they also have flaws.

[88] 47 USC §309. See further Chapter 5.

[89] See Goodman, E, McCoy, S, and Kumar, D, 'An Overview of Problems and Prospects in US Spectrum Management', *Telecommunications Convergence: Implications for the Industry & for the Practicing Lawyer*, 698 PLI/Pat 327 (Practising Law Institute, New York, 1 May 2002).

[90] See 'In the Matter of FCC Report to Congress on Spectrum Auctions', FCC 97-353 (Federal Communications Commission Washington DC, 30 September 1997), 7.

[91] Ibid.

[92] Brito, J, 'The Spectrum Commons in Theory and Practice', (2007) Stan Tech L Rev 1, paras 5–7, <http://jerrybrito.com/pdf/2007StanTechLRev1.pdf>.

[93] See regarding recent US caps/set asides, text accompanying n 31; regarding the recent UK applied overall and bandwidth spectrum caps for 5G auctions, see text accompanying n 29.

For example, concerns were raised about the massive overbidding for 3G spectrum[94] and the high debt levels the successful undertakings incurred long before they could realize the value of the spectrum.[95] It has also been shown that auctions may not necessarily be efficient. This can occur, eg where overbidding, whether collusive or not, is intended to foreclose the market to new entrants,[96] or where intimidatory collusion occurs via threats of retaliatory bids, or where bidders coordinate and reduce their demand to lower prices.[97] The emphasis on maximizing government revenues from spectrum auctions has also been called into question for failing to ensure that policy objectives underlying auctions including efficient and most productive use are, in fact, occurring.[98] It is further criticized for failing to allow for spectrum use for broader social objectives that would be undertaken ordinarily by organizations unlikely able to compete in a price-based auction.[99] Another criticism of pure price auctions is that they can inhibit the roll-out of innovation beyond existing technology, eg the long-term licences viewed as necessary to recoup costs and justify infrastructure investment.[100]

Not all market economies, however, have exclusively used a highest bidder approach. For example, Finland, allocates certain blocks of spectrum for development, research, and teaching in geographical areas, See FICORA, Regulation 2500–2690 MHz Auction (Helsinki, 2009), s 7. The US has unlicensed bands available for use as a 'commons', subject to Part 15 device rules that require they operate on the principle that interference must be tolerated. The UK as well has allocated blocks of spectrum for low-powered unlicensed use as a commons. Also recently the UK applied overall and bandwidth spectrum caps for the 5G auctions. See text accompanying n 31.

[94] See Ozanich, G, Hsu, C, and Park, H, '3G Wireless Networks as an Economic Barrier to Entry: The Western Experience', (2004) 21(3) Telematics and Informatics 225.

[95] See generally, Rose, G, 'Spectrum Auction Breakdown: How Incumbents Manipulate FCC Auction Rules to Block Broadband Competition', Working Paper 18 (New America Foundation 2007), <http://www.newamerica.net/files/WorkingPaper18_FCCAuctionRules_Rose_FINAL.pdf>.

[96] Ibid. Verizon Wireless (perhaps the largest US wireless carrier) sold the 'A' and 'B' Block spectrum it bought at auction in 2008 but never used in exchange for FCC permission to buy licences from a former cable company wireless venture for spectrum that would better enable its 4G national network. There was considerable industry criticism of Verizon's alleged 'warehousing' of spectrum to keep it out of competitors' access and, although the sale/exchange was finally approved, it was subject to regulatory scrutiny. See FCC, Letter to Verizon Wireless (Washington DC, 15 May 2012), <http://transition.fcc.gov/Daily_Releases/Daily_Business/2012/db0515/DOC-314071A1.pdf>.

[97] See generally, Bajari, P and Fox, JT, 'Measuring the Efficiency of an FCC Spectrum Auction', NBER Working Paper No. 11671 (2005, rev 2009) (and other works cited therein, 1), <http://fox.web.rice.edu/published-papers/fox-and-bajari-aej-micro.pdf>.

[98] See generally, Hazlett, TW and Muñoz, R E, 'What Really Matters in Spectrum Allocation Design', (George Mason Law & Economics Paper No.11-48 27, October 2011), <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1961225>.

[99] Industry groups have suggested, however, that restrictions/set asides for other uses have only ultimately produced delays, enhanced costs, lower state revenues, and proved to the ultimate detriment of consumers over unrestricted pure price auctions. See Position Paper: 'The Case for Inclusive Spectrum Auction Rules: How Failed International Experiments with Auction Bidding Restrictions Reveal the Strength of Inclusive Rules that Put Consumers and Innovation First' (MobileFuture.org, September 2013).

[100] See Milgrom, P, et al, Working Paper 17-028 'Redesigning Spectrum Licences to Encourage Innovation and Investment' (Stanford Institute for Economic Policy Research, October 2017) (suggesting perpetual but

The UK regime is at one level an example of the approach to spectrum regulation that can be found in other countries. However, as an EU Member State (and seemingly likely to continue with comparable approaches to its sector regulation beyond its exit of the EU), the UK regime is compliant with the EU framework that really has influenced it (or vice versa, more likely) in the last thirty years. An examination of one necessarily requires examination of both. The following, therefore, looks at the UK's historical regulation, turns to the EU framework and requirements for spectrum and its licensing, and then considers how the recent UK framework complies.

7.4.3.1 *The UK and historical regulation of spectrum—from wired to wireless telegraphy*

The UK public regulation of the telegraphy, wired and wireless, stems from the historical framework for provisioning and regulating posts as a public necessity, discussed in Chapter 6. The invention of the telegraph prompted the nationwide building of networks necessary to provide these services. To address their rapid expansion, the government passed several Telegraph Acts in the 1860s. The Telegraph Act of 1863[101] was designed to regulate the rights of telegraph companies to install lines throughout the country, effectively code powers. Telegraphy, then, was still a privately owned enterprise. Subsequent legislation changed this. The Telegraph Act of 1868,[102] incorporating the provisions of the 1863 Act, granted the Postmaster General the right to acquire and operate the inland telegraph systems in the UK.[103] Before this took effect, the 1869 Act was passed, granting the Postmaster General an 'exclusive privilege' in the General Post Office to operate telegraph services in the UK but not subject itself to a licence or regulation as a government department.[104] The Act exempted only certain entities such as railroads, canals, and limited other undertakings, such as Lloyds of London, providing these for their own use. However, a licence granted by the Postmaster General was required for other companies wishing to provide telegraph services.[105] The Telegraph Act of 1870 nationalized telegraph services.[106] This later extended to telephones when the definition of telegraph under the Act was construed to include telephony that could then no longer be provided by a private company.[107]

depreciating licences where annual fees are based on a declared value at which the licensees would be willing to sell the licence and that must be sold at that price).

[101] Telegraph Act 1863, <http://www.legislation.gov.uk/ukpga/Vict/26-27/112/contents>. See further Chapter 3.

[102] Telegraph Act 1868, <http://www.legislation.gov.uk/ukpga/Vict/31-32/110/contents/enacted>.

[103] Records of the Post Office and British Telecommunications public corporation: 1849–1984, BT Digital Archives, <http://www.digitalarchives.bt.com/Calmview/Record.aspx?src=CalmView.Catalog&id=BTA%2f3+BT1>.

[104] Ibid. [105] Ibid.

[106] Telegraph Act 1870, <http://www.legislation.gov.uk/ukpga/Vict/33–34/88/contents>.

[107] *Attorney-General v The Edison Telephone Co of London, Ltd* [1880–81] LR 6 QBD 244.

The Postmaster General's exclusive privilege in telegraphic systems did not extend to communications exchanged by wireless telegraphy with foreign countries or with ships beyond its territorial waters.[108] Also, Lloyd's operated its own wireless systems, the provisioning of which was involved in the Marconi contract. A grant of powers was needed to effect controls over spectrum use for wireless systems without disturbing the framework already established for telegraph services under the current national law. In 1904, the UK passed the first Wireless Telegraphy Act, granting the Postmaster General the power to license the use of radio spectrum.[109]

In 1908, the General Post Office built its first ship-to-shore wireless coast station, and licensed others. In 1909, the General Post Office acquired most of Marconi's wireless coast stations[110] and, as with telephony systems, continued to take over others throughout the country including those operated by Lloyd's. The UK, in 1913, ratified the International Radio Conference—on the heels of wireless telegraphy's role in saving over 700 lives onboard the Titanic in 1912 with its Marconi systems able to radio for assistance.[111] Wireless telegraphy and coastal stations operations by the GPO continued well into the twentieth century.

The national frequency management infrastructure that exists in the UK today began in 1918 with the establishment of the Wireless Telegraphy Board[112] to manage interference problems. The Post Office represented non-government users' interests throughout the board's various reconfigurations until it was disbanded in 1948. The Wireless Telegraphy Act of 1949 vested powers in the Postmaster General generally to license all apparatus using radio frequencies.[113]

The Post Office Act 1969 abolished the GPO and moved spectrum management authority to the former Ministry of Posts and Telecommunications.[114] Responsibility passed in 1974 to the Home Office, and in 1983 to the former Department of Trade and Industry's Radio Regulatory Division. In 1990, it became an executive agency within the former DTI called the Radiocommunications Agency (RA) operating under the Wireless Telegraphy Act as amended over time.

The RA merged with Oftel and three other agencies in 2003 to form Ofcom, a converged regulator intended to better address convergence in electronic communications networks and services. Ofcom now regulates spectrum under the Wireless Telegraphy Act of 2006 and the Communications Act 2003, which were

[108] Preliminary Conference, n 60.

[109] Records of the Post Office and British Telecommunications public corporation: 1849–1984, n 103.

[110] Ibid. [111] Ibid, 1912.

[112] See DEFE 59, Record Summary, 'Ministry of Defence and predecessors: Defence Signal Board and predecessors: Minutes and Papers' (National Archives), <http://discovery.nationalarchives.gov.uk/details/r/C15205>.

[113] Wireless Telegraphy Act 1949, s 1. [114] Post Office Act 1969, s 3(1).

amended not only to reflect that change but also to pursue a more market-driven approach to spectrum regulation in contrast to the administrative allocation processes with command and control oversight. Some amendments to these Acts also reflect changes required by European Union telecommunications frameworks that have evolved with respect to spectrum. Although the UK wireless framework precedes the EU's by nearly eighty-five years, it must comply with the EU's requirements for licensing radio spectrum. It may be helpful therefore now to examine the EU regime in this regard.

7.5 THE EU SPECTRUM FRAMEWORK

As noted in Chapter 4, the EU telecommunication frameworks can largely be divided into three phases. Pre-EU regulation, the European market generally comprised state-owned monopoly for all services or with the monopolist empowered to license equipment attached to the network and perhaps the provision of value-added wireless services, eg paging or radio-car services by others. The second phase, the initial EU regulatory regime focused largely on the liberalization and harmonization of fixed-line communications operated primarily by these monopolists. However, a 1996 service liberalization Directive required the removal of any special and exclusive privileges in the provision of mobile and personal communications services and harmonized the list of essential requirements permitted to justify restrictions.[115] Other key provisions of this phase concerned the EU-wide technical harmonization by 1991 of the spectrum bandwidths to be used in pan-European digital mobile communications,[116] and provisions for mutual recognition of type approvals for telecommunications terminal equipment.[117] Thus the EU mandated an EU-wide bandwidth allocation in the 900 MHz range for digital (2G) wireless cellular telephony, called Global Standard Mobile, or 'GSM', intended to overcome the disparate national cellular systems and their inability to be used cross-border with handsets likely not operable on other frequencies. The GSM Directive also required the clearing of further bands beyond that initially mandated so that progressively greater spectrum would be available.[118] With

[115] Directive 96/2/EC amending Directive 90/388/EEC with regard to mobile and personal communications, OJ L 020/59, 26 January 1996.

[116] Directive 87/371/EEC on the frequency bands to be reserved for the coordinated introduction of public pan-European cellular digital land-based mobile communications in the Community.

[117] Directive 86/361/EEC of 24 July 1986 on the initial stage of the mutual recognition of type approval for telecommunications terminal equipment.

[118] The Directive stated that it intended to enable the exclusive occupation of the 890–915 and 935–960 MHz frequency bands for digital cellular communications.

the Terminal Equipment Directive, the EU sought to ensure transparency and simplified, objective procedures for the licensing of equipment attached to networks, in order to meet essential requirements for user and network safety by requiring mandatory approval of equipment manufactured to specifications set by designated independent bodies. The subsequent Radio and Telecommunications Terminal Equipment Directive (R&TTE)[119] harmonized the rules for market entry of all equipment using radio frequency spectrum as well as all terminal equipment attached to public telecommunication networks. It applied to a vast array of kit including: mobile handsets, other various kinds of radio equipment such as mobile GSM and UMTS base stations; car-door openers and other short-range radio devices; and fixed network terminal equipment such as normal analogue telephones, ISDN terminals, cable, and PC modems.[120]

The main changes brought about by the R&TTE Directive included the introduction of the equipment manufacturers' declaration of conformity to type. The manufacturer's assessment of its applicable equipment's ongoing conformity with the Directive's requirements (by way of European Telecommunication Standards Institute standards) is its responsibility without need to obtain a further approval or certificate from an official body after passing the required initial tests in a legally recognized laboratory. In addition to streamlining processes, the R&TTE Directive also imposed less stringent requirements. For example, fixed network terminal equipment was only required to satisfy electrical safety and electromagnetic compatibility requirements, with radio equipment limited to the requirement to use spectrum efficiently and without harmful interference. However, under the Directive, the EU could still, in certain cases, introduce additional public interest requirements, such as for 'safety critical' radio equipment, eg on ships. The Radio Equipment Directive (RED) replaced the R&TTE Directive in 2016. The new Directive encompasses any equipment placed on the market/put into service that emit or receive radio waves intentionally for communications or radio determination[121] operating below 3000 GHz.[122] Radio and TV broadcast equipment, receive only, and equipment operating below 9MHz that were previously excluded from the R&TTE Directive must now also comply with the essential requirements of safe, effective, and efficient non-interfering spectrum use,

[119] Directive 1999/5/EC on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity, OJ L 91/10, 7 April 1999.

[120] Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC, OJ L 153/62, 22 May 2014.

[121] Devices using wave propagation to determine position, eg RFID or radar.

[122] Arts 1, 2 RED (with the exception of devices exclusively used for military, state security, amateur radio, and civil aviation).

among other things.[123] The RED continues the prior self-certification for harmonized standards as one of the possible mechanisms for conformity. A notified body must assess if these requirements are met where harmonized standards don't exist before self-certification is possible. The CE mark of such technical compliance is still required. The RED requires that where equipment has restrictions on putting into service or of requirements for authorization of use, information on the packaging must allow identification of the applicable Member States as set by the Commission.[124]

The EU's continuing approach of technical and other harmonization for open network provision based on cross-border and pan-European considerations together with its 'essential requirements'-only licensing mandates comprises the essence of the EU spectrum regulation.[125] The harmonizing GSM Directive was amended to permit technological neutrality and refarming of spectrum for 2G, under harmonized technical conditions set out in Commission decisions, to be used for 3G and 4G technologies.[126]

The Licensing Directive 97/13/EC, in the first phase of EU regulation, contained a stated default for general authorizations but clearly permitted individual licences to accord rights to use spectrum, impose conditions, and limit the number of licences where necessary to ensure spectrum's efficient use as a scarce resource.[127] The Directive also only seemed to contemplate market-pricing structures such as auctions within the context of an individual licence.[128] These factors, combined with the vast discretion permitted to the National Regulatory Authorities (NRAs), resulted in the varying individual licences and processes remaining the rule across Europe rather than

[123] Art 3(1)(a) and (b) (incorporating by reference the essential safety and electromagnetic compatibility requirements of respectively Directive 2014/35/EU on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits (the Low Voltage Directive but without the low voltage limits) and Directive 2014/30/EU on the harmonisation of the laws of the Member States relating to electromagnetic compatibility) and Art 3(2) (adding 'efficient use') and (3), RED.

[124] Art 10(10). See also Commission Implementing Regulation (EU) 2017/1354 specifying how to present the information provided for in Article 10(10) of Directive 2014/53/EU, OJ L 190/7, 21 July 2017.

[125] This is reflected eg in the Roaming Regulation which sets a mandatory glide path of wholesale and retail pricing for cross-border roaming service provision which harmonization has been extended to voice and SMS in order to force down prices in these, to date, monopoly cross-border call-termination markets.

[126] Directive 2009/114/EC amending Directive 87/372/EEC on the frequency bands to be reserved for the coordinated introduction of public pan-European cellular digital land-based mobile communications in the Community, OJ L 274/25, 20 October 2009. Two Commission Decisions have provided the harmonized technical rules for the extension of the 900/1800 bands to 3G and more recently 4G uses.

[127] See Directive 97/13/EC, Recitals 3, 7, 13, on a common framework for general authorizations and individual licences in the field of telecommunications services.

[128] Ibid, at Art 11.

the exception intended only for 'limited, pre-defined' circumstances justifying their imposition.[129]

The EU largely limited this discretion by mandating the use of general authorizations in the 2002 Authorisation Directive,[130] part of a revised post-liberalization framework to address maturing competition but continuing *ex ante* regulation in markets still not effectively competitive, the ongoing third phase of EU telecommunications. The Authorisation Directive's limited exceptions to the general authorization requirement include grants of rights to use spectrum but it states that Member States are to 'facilitate' the rights to use spectrum under a general authorization (Article 5(1)).

A recast framework via the EU Electronic Communications Code (EECC) was proposed in 2016 by the Commission for, inter alia, the purpose of ensuring more harmonized and consistent spectrum management and regulation to address both the Commission's concerns of delayed and fragmented 4G roll-out and take-up in most of the EU and, anticipating 5G attributes[131] and the prospective cumulative demand for spectrum, the need to make available more spectrum, including by sharing. The proposed Code includes some new harmonized measures: durations of twenty-five years for licenses of harmonized bands (Article 49(2)); a non-binding but mandatory peer review of spectrum-related decisions, establishing an Article 7, Framework Directive-like approach for spectrum (Article 35(2)–(5)); a harmonized list of spectrum-related measures that NRAs are to have the power to adopt (Article 35(1)); a single set of conditions that can be attached to spectrum rights of use (Annex 1 (D)); enhanced NRA duties of spectrum management (Article 45(2)) and; factors for consideration in spectrum decisions (including individual licence decisions, limited grants, fees, reserves, award process design) (Article 42). It also provides for harmonized but voluntary pan-European/multicountry joint authorization processes (Article 37), apparently giving up on mandatory one-stop shop efforts.

The Code continues the Directive's preference for the general authorization for spectrum use but reinforces it by, among other things:

- adding shared spectrum to uses under the general authorization;[132]
- specifying clearly that grants of individual rights of use for spectrum are limited to situations where such rights are necessary to maximize efficient use;

[129] Commission Communication, 'Toward a new framework for electronic communications infrastructure and associated services: The 1999 Communications Review' (1999 Communications Review), COM(1999) 539, 10 November 1999. Accord, Commission Communication, '5th Report on the implementation of the Telecommunications Regulatory Package' (1999).

[130] Directive 2002/20/EC on the authorization of electronic communications networks and services, OJ L 108/21, 24 April 2002.

[131] This will include denser networks and at higher bands, mass M2M communications with over 100 x the number of connected devices, ubiquitous connectivity, and ultra low latency.

[132] A potentially significant issue for 5G uses. See eg Presentation, '5G Spectrum Sharing' (Qualcomm, 2 December 2016), <https://www.qualcomm.com/invention/technologies/5g-nr/spectrum-sharing>.

- requiring Member States in all other cases to set out in advance the conditions for use of spectrum in a general authorization (Article 46(1)).[133]

The proposed EECC would also further refine the circumstances of individual grants of rights. The Directive now states that Member States can only require individual rights where necessary to: avoid harmful interference, safeguard efficient use of spectrum, ensure technical quality of service, or fulfil other general interest objectives (Article 5(1)). The proposed Code rewords this, perhaps tilting away from a possible single decision defaulting to individual grants where potential challenges to a general authorization exist. It would require that Member States decide on the most appropriate regime for permitting the use of radio spectrum, whether by general authorization or individual grant, taking into account factors that include the:

- specific characteristics of the spectrum concerned;
- need to protect against (rather than avoid) harmful interference;
- requirements for a reliable sharing arrangement, where appropriate;
- appropriate level of receiver resilience to ensure technical quality of communications or service;[134]
- objectives of general interest (Article 46, proposed EECC).

The proposed EECC thus changes slightly the criteria for deciding whether individual grants of use can be permitted. It enhances the technical considerations (arguably objective) that must be explored seemingly with a view to resolve them on the technical merits before a weighted decision of which regime is appropriate in each case can be determined. The Code however permits the Commission to adopt implementing acts on how Member States apply the above criteria, including governing issues relating to sharing, receiver resilience, and protecting against harmful interference (Article 46). The proposed Code would similarly allow the Commission, as a technical implementing measure, to determine whether rights in harmonized bands are subject to a general authorization or individual rights of use (Article 45(2)). BEREC has objected to both of these harmonizing implementing measures as encroaching on NRAs' ability to determine needs according to national conditions, possibly where a general authorization was mandated but individual licences might be more appropriate, such as existing users in the band or the adjacent band use differs. Also, they contend that harmonized

[133] See also Recitals 113–114, proposed EECC.

[134] Adequate receiver resilience is critical to protect against harmful interference. This will be important for denser networks as will be likely in 5G using higher bandwidth as well as for shared spectrum. With enhanced requirements for receivers under the RED, the issue there and here is getting enhanced regulatory focus.

requirements for individual grants of use where not needed in the national market could 'sterilise valuable spectrum resources'.[135]

The inclusion of suitable sharing agreements within the decision criteria for granting individual versus general authorizations evidences the proposed Code's support of spectrum sharing. This support is further reflected in: the Code's specific definition of sharing indicating that spectrum can be shared on a licensed or unlicensed basis and under both the general authorization or individual licence or combination of the two (Article 2(26)); the NRA harmonization duty to maximize spectrum sharing by ensuring the least onerous authorization system possible (Article 45(2) and; the inclusion of the ability to set access conditions for necessary spectrum sharing among the harmonized competences that NRAs must have (Article 35 (1)(f)). Notable in this regard are, however, the network operators' objections to the greater use of spectrum sharing, general authorizations for spectrum rights, and other 'deregulation' such as allowing third parties to provide RLAN at the edge of fixed networks (Article 55) in order to preserve their status quo on markets.[136]

The proposed EECC would continue the specific time frames for the process within which individual grants of rights must be awarded, including for spectrum use, under the Authorisation Directive's specified procedures. As considered in Chapter 6 these include a time limit of six weeks for grants of radio frequencies that have been allocated for specific purposes under the national frequency plan (Article 5(3)). For allocations by competitive/comparative procedure, a further extension of no longer than eight months is permitted to ensure that the process is fair, reasonable, and open (Article 7(4)). Under the proposed EECC, however, time frames allow for the possibility of a harmonized date set by the Commission for completion of the specific frequency allocation (Article 54(8)).

The Authorisation Directive permits restrictions on the numbers of persons granted individual rights to use spectrum only where 'unavoidable' and dictated by scarcity and the need to ensure efficient use[137] following procedures for consultation with interested parties and publication of NRA decisions with reasons

[135] BoR (17) 91 'BEREC's Paper on the Commission's Proposals for an EECC Spectrum Provisions—Implementing Acts' (BEREC, 27 April 2017).

[136] See Orange Position Paper, 'Spectrum Management: The European Electronic Communications Code', December 2016, <https://www.orange.com/en/Group/Committed-to-Europe/The-new-Code-EECC>; European Telecommunications Network Operators' Association Position Paper on the European Electronic Communications Code (ETNO, January 2017), <https://etno.eu/datas/positions-papers/2017/ETNO%20Position%20Paper%20on%20the%20EECC>.

[137] Recital 11, Directive 2002/20 as amended 2009. While the recital addresses both spectrum and numbers, it and Art 5, also addressing both, fail to make clear whether these two criteria for limitation apply both to spectrum and numbers, the other individual grant, possibly due to unfortunate wording. However, this would make sense as both are considered scarce public resources, for which ensuring efficient use would seem commensurate under the 'public trust' theory discussed in Chapter 6 at Section 6.2.2.

justifying the limitation. The grant of such limited rights must be on the basis of selection criteria that are objective, transparent, non-discriminatory, and proportionate (Article 7(3)). The Directive requires review of the grant limitation at reasonable intervals for continued justification. Where not, the NRA must publish that decision and invite applications for further grants of such rights. Both users of communications services and providers of networks and services are eligible to obtain spectrum use grants (Article 5(2)).

The proposed EECC does not directly refer to selection criteria for limited grant. It rather first requires Member States to state the reasons for the limitation on rights of use, giving due weight to the need to maximize benefits for users and to facilitate the development of competition (Article 54(1)(a)). It then requires Member States to clearly define and justify the objectives pursued with the selection procedure, and where possible quantify them, giving due weight to the need to fulfil national and internal market objectives (Article 54(2), proposed EECC). Possibly referring to the same 'objectives', the proposed Code then specifies that the objectives that Member States may set out for the grant, with a view to design the specific selection procedure, must be limited to one or more of:

- promoting coverage;
- required quality of service;
- promoting competition;
- promoting innovation and business development; and
- ensuring that fees promote optimal use of radio spectrum in accordance with Article 42 that requires they be objectively justified, transparent, non-discriminatory, and proportionate in relation to their intended purpose and take into account an extensive list of policy objectives.[138]

[138] Art 54(2), proposed EECC. The objectives referenced in Art 42 include: the Art 3 general regulatory objectives of promoting regulatory consistency and predictability, non-discrimination, technological neutrality, promoting high capacity data connectivity, promoting competition in provision of networks, including efficient infrastructure-based competition and services, contributing to the development of the internal market, and promoting the interests of citizens; the Art 4 spectrum coordinating 'aim of optimising the use of radio spectrum and avoiding harmful interference'; and the Art 45(2) objective of spectrum harmonisation of use of radio spectrum, consistent with the need to ensure effective and efficient use thereof and in pursuit of benefits for the consumer such as economies of scale and interoperability of services and networks by, inter alia,

(a) ensuring coverage of their national territory/population at high quality and speed, both indoors and outdoors, including along major transport paths, including the trans-European transport network;
(b) ensuring that areas with similar characteristics, in particular in terms of network deployment or population density, are subject to consistent coverage conditions;
(c) facilitating rapid development in the Union of new wireless communications technologies and applications, including, where appropriate, in a cross-sectorial approach;
(d) ensuring the prevention of cross-border or national harmful interference in accordance with Articles 28 and 46 respectively, and taking appropriate pre-emptive and remedial measures to that end;

The proposed Code requires the further layering that the Member State clearly define and justify the selection procedure choice, including any preliminary phase in order to be able to access the selection procedure. Member States must also state the outcome of any related assessment of the competitive, technical, and economic situation of the market and provide reasons for the possible use and choice in adopting any measure under the required NRA competences under proposed Article 35.[139] Any exercise of these would be subject to the previously noted, mandatory but non-binding prior 'peer review' by BEREC, the Commission, and other NRAs, designed to ensure better harmonization of spectrum management (Article 35(2), proposed EECC). This requirement has been criticized for various reasons including in the context of the award process that it is unnecessarily complex, delaying, and likely unworkable, eg, since the review would occur at the final design stage of the award process after rounds of public consultation with any proposed changes further delaying the award and requiring further consultation. The practical feasibility of the regulators to conduct reviews of the very complex award processes within the fairly short time frames, especially under harmonized deadlines where all twenty-eight Member States would have award processes, is also questioned.[140]

Individual rights to use spectrum under the Authorisation Directive can currently be subject to conditions that may only include those regarding:

- service or technology designations for granted frequency;
- effective and efficient use including coverage requirements;
- technical and operational conditions for avoiding harmful interference and public exposure to electromagnetic fields;
- usage fees;
- duration;

(e) promoting shared use of radio spectrum between similar and/or different uses of spectrum through appropriate established sharing rules and conditions, including the protection of existing rights of use, in accordance with Union law;
(f) applying most appropriate/least onerous authorisation system possible in accordance with Article 46 in such a way as to maximise flexibility, sharing and efficiency in the use of radio spectrum;
(g) ensuring that rules for the granting, transfer, renewal, modification and withdrawal of rights to use radio spectrum are clearly and transparently defined and applied in order to guarantee regulatory certainty, consistency and predictability;
(h) ensuring consistency and predictability throughout the Union regarding the way the use of radio spectrum is authorised in protecting public health against harmful electromagnetic fields.

[139] These would include, in keeping with relevant proposed Code's requirements: the selection process; bidder eligibility criteria, parameters of spectrum economic valuation measures; rights duration and renewal conditions; measures necessary to promote competition; conditions for transferring and assigning spectrum (including by leasing and trading), sharing spectrum or wireless infrastructure; and limiting individual spectrum accumulations. Peer review as per Art 35 (2), proposed EECC.

[140] BoR 17/129 'Peer Review Process (Article 35)' (BEREC, 30 May 2017).

- transfer by the grantee; and
- commitments made in competitive/comparative selection procedures.[141]

Individual conditions must be objectively justified according to the service involved, proportionate, transparent, and non-discriminatory (Article 6(1)). They must not duplicate the general conditions or conditions applicable to undertakings by national law (Article 6(3)). However, information can be required to ensure entities can comply with conditions.

The proposed EECC is a bit of a 'hot mess' on conditions regarding spectrum. It has two separate provisions governing conditions, Articles 13 and 47, the latter possibly lex specialis.[142] Article 13 continues the overarching criteria for conditions, including that individual conditions not duplicate legislation or those in the general authorization. While stating that only the conditions in Annex I can apply to the general authorization for the provision of electronic communications networks or services and the rights of use for radio spectrum and numbers, it provides that only the conditions specific to that sector contained in Annex I, A, B, and C are to apply to the general authorization and implicitly for individual grants, Annex I (D) that replicates many of the former Annex B conditions but also:

- enables conditions regarding obligations to pool or share radio spectrum or allow access to radio spectrum for other users (Annex I, D(8)); and
- extends the regulatory processes for which conditions regarding prior commitments for the spectrum grant can be imposed to any authorization or renewal process, including invitation processes (Annex I, D(7)).

The only provision in the Code specifically governing spectrum under the general authorization is that under Annex I, B (for the provision of networks) that allows, as with the Authorisation Directive, conditions for the use of radio spectrum, in conformity with 'Article 7(2)'[143] of Directive 2014/53/EU where such use is not made subject to the granting of individual rights of use in accordance with Articles 46(1) and 48 (the procedures for granting individual rights under the Code). This would suggest, therefore, that only conditions limited to essential requirements under the RED may be imposed. Possibly the RED's efficient/effective use restrictions and avoidance of harmful interference requirements can encompass general

[141] Part B, Annex.

[142] Art 13 'Conditions attached to the general authorisation and to the rights of use for radio spectrum and for numbers, and specific obligations'; Art 47 'Conditions attached to general authorisations and to rights of use for radio spectrum.' The omission of the additional categories of numbers and specific obligations in Art 47 indicates its likely status as lex specialis.

[143] There is no subsection (2) in Art 7 of the Radio Equipment Directive, likely a drafting oversight here. Article 7, Radio Equipment Directive limits restrictions for radio equipment to those concerning efficient/effective use, avoidance of interference, and electromagnetic disturbances and public health.

authorization conditions of use to address both the Commission's goal of spectrum sharing facilitation and the Article 47(1) provision, also governing conditions for both authorizations and grants, that they are to include a level of use requirement. The Commission suggests that this specific provision, combined with the ability to monitor compliance with conditions and implement remedies for their breach under Articles 30 and 47, amounts to a 'use it or lose it' requirement,[144] if somewhat opaque.

Proposed Article 13(1) adds that conditions for rights of use are to be in keeping with Articles 45 and 51. This seemingly requires, under Article 45, consideration of all of the spectrum management factors as eg, for the decision to grant individual rights under Article 45(1) and (2), the Article 45(4) provisions for restrictions on technological neutrality as necessary, and the section 45(5) service neutrality restrictions (continued from the Framework Directive). Somewhat circularly, Article 47 requires that conditions for both rights of use and the general authorization conform to Article 13(1). Likely objectionable to the Member States and BEREC is the Article 47(3) provision allowing the Commission 'to specify the modalities of applying the conditions that Member States may attach to authorisations to use harmonised radio spectrum.'

Under the Authorisation Directive, usage fees may be charged for spectrum rights to ensure their optimal use and can cover activities not encompassed within the administrative fees. Although a lump sum payment can result from a comparative or competitive selection process, these payments must not detract from the requirement that allocations be designed to ensure their optimal use, seemingly only an *ex ante* determination.[145] The proposed EECC complicates an already complicated process. As previously discussed in the context of award design, it requires that fees be set taking into account a complex list of regulatory objectives, encompassing the enhanced general regulatory objectives (Article 3) (as currently required for all regulatory action), and the objectives for spectrum coordination (Article 4) and harmonization (Article 45(2)) that, although including efficient and effective non-interfering use to maximize the benefit to consumers, have a range of different factors to be considered.[146] How a regulator is to take all of these into account in a sensible balancing and ensure that they are implemented accordingly, for example, in a spectrum auction, is to be questioned. Other considerations are further layered into the fee determination (and likely therefore, process design). These specify that Member States in their grant

[144] European Commission, 'Review of the Electronic Communications Regulatory Framework: Executive Summary 3: Wireless Networks and Spectrum', at s 2.2.

[145] See Recital 32, Art 13, Authorisation Directive 2002/20/EC as amended.

[146] See text and accompanying n 138.

of these rights to use this public resource must have a coherent approach in setting fees that should not provide an 'undue financial burden' linked to the rights of use for undertakings providing electronic communications networks and services (not limited to public) (Article 42(4); Recital 93). They also indicate that Member States are to ensure that fees not only reflect the economic and technical situation of relevant markets and any other significant factor determining the rights' value but also that they be set in a manner enabling innovation in network and service provision as well as competition, while also ensuring that award processes provide safeguards against distorted fees resulting from revenue maximization policies, anticompetitive bidding, or similar behaviours (Recital 94). The proposed EECC further addresses pricing reserves in any award process, requiring that these reflect the additional costs associated with fulfilling conditions imposed to further policy objectives not reasonably met under normal commercial standards, such as territorial coverage obligations (Article 42(2); Recital 95). This universal service-like cost consideration is not however required to be counterbalanced with any benefits that might derive from the obligation such as the benefits of ubiquity for brand such as are built into the current USO cost/benefits analysis. Proposed fee reserves and other spectrum economic valuation measures would also be subject to the peer review process (Articles 42, 35, proposed EECC).

The Commission intends that these proposed changes ensure a greater harmonization in the allocation and management of spectrum throughout the EU, a problem it has sought to address in various ways since 2002. The 2002 Radio Spectrum Decision[147] established a framework for EU coordination of spectrum management approaches across the EU working with the European Conference of Postal and Telecommunications Administrations (CEPT) to establish the technical parameters. Under the Decision, the Commission can harmonize the technical conditions for the use of spectrum to ensure its efficient use, its access conditions at the EU level, and the interoperability of radio equipment. A Radio Spectrum Policy Group comprising expert members from the Member States and chaired by the Commission assists in the work via reports and opinions on strategic spectrum policy and coordination issues. Since 2002, the Commission has made over two dozen decisions harmonizing spectrum band uses and setting harmonized conditions for use and updated or amended these over time to reflect technological developments and permit refarming. These include decisions to permit public mobile radio access networks based on low power licence-exempt

[147] Decision 676/2002/EC, OJ L108/1, 24 April 2002.

WiFi technologies at 5 GHz[148] and the refarming of the 900 MHz and 1800 MHz bands for 4G.[149]

That the Commission continues to perceive this as inadequate to develop an EU-wide harmonized market on the scale of that of the United States is clear from its other various proposals to enhance EU-centralized control over spectrum management. These have included the 2007 proposal for creation of a European Telecommunications Market Authority with delegated powers to oversee spectrum regulation and allocation to avoid what it perceived as fragmented national regulation and uneven roll-out of advanced mobile services. The Member States resoundingly rejected this, guarding their prerogatives over this valuable resource and their regulatory competences (as they similarly did with a 2013 'Connected Continent' proposal for a Commission 'veto' over national regulatory decisions).[150] They will likely also reject the Commission proposals to change BEREC to operate on a more EU agency-like basis, discussed in Chapter 6 and the 'double lock' that would allow the Commission ultimately to veto NRA proposed actions in an Article 7 (proposed Articles 32(3), 33) review of market definitions and remedies if both the Commission and BEREC agreed that the NRA proposed action was inappropriate, further discussed in Chapter 9.

BEREC has not only decried the double veto but also what it calls the 'hard harmonisation' of spectrum in the proposed EECC.[151] This has been a significant balance of competence issue for over the last decade. The development of pan-European markets using spectrum has been noted to be threatened by the varying national approaches to spectrum management and regulation, including trading and refarming of spectrum. In the latter context this was true for the 'digital dividend', the vast blocks of spectrum that were being freed up, essentially globally, for other use by the switch from analogue broadcast television to digital terrestrial television. This was a one-off opportunity to repurpose spectrum that had been tied to a specific use and technology for many decades. A lack of EU-wide harmonization here might have resulted in purely local and possibly non-technological considerations being applied to valuable spectrum with propagation characteristics that made it suitable for wide area delivery, eg 3G and 4G wireless broadband

[148] Commission Decision 2005/513/EC on the harmonised use of radio spectrum in the 5 GHz frequency band for the implementation of Wireless Access Systems including Radio Local Area Networks (WAS/RLANs), OJ L 187/22, 19 July 2005.

[149] Commission Decision 2009/766/EC on the harmonisation of the 900 MHz and 1800 MHz frequency bands for terrestrial systems capable of providing pan-European electronic communications services in the Community, OJ L 274/32, 20 October 2009.

[150] See Commission Memo 08–04 'Commission welcomes European Parliament vote to strengthen the EU's Single Market for Telecoms but important questions remain open' (Brussels, 8 July 2008).

[151] BEREC Press Release BoR (17) 95 'BEREC Papers on the Review' (BEREC, 11 May 2017).

services or enhanced broadcast and mobile services, among others. Such divergent decisions could have implications for decades since available spectrum below 1 GHz is rare with previous allocations having occurred half a century ago in the UK.

With an EU centralized regulator shot down, the Commission's reforms proposed in 2007 and adopted as amendments to the Framework Directive via the 2009 'Better Regulation Directive' contained specific provisions that, if not full Commission control, enabled higher levels of harmonization and cooperation among the Member States and the Commission in strategic planning for spectrum use. Building on earlier harmonization measures such as the Radio Spectrum Policy Decision, these arguably were a new order of spectrum regulation within the EU and with the Commission more in the driver's seat as a result of: (1) enhanced Member State duties of cooperation and spectrum management requirements and, notably, (2) legislative proposals authorized to be made by the Commission in a multi-annual programme of spectrum objectives and adopted under the co-decisional procedure (now the 'ordinary procedure'), both considered as follows.[152]

The duties of cooperation arose under Article 8a, Framework Directive that imposed somewhat amorphous obligations of enhanced planning, coordination, and harmonization by Member States at the EU level regarding spectrum policy. Relevant factors for their consideration in optimizing the use of radio spectrum and avoiding harmful interference include:

- economic, safety, health, public interest, freedom of expression, cultural, scientific, social, and technical aspects of EU policies, and
- the various interests of radio spectrum user communities.

This remains unchanged under the proposed Code (Article 4).

Article 9 of the Framework Directive addresses spectrum management and imposes the requirement that spectrum allocations be service and technologically neutral in order to permit greater market flexibility and allow providers to use any possible technology in a spectrum band and provide any service possible via the spectrum available under the national frequency allocation plan (Article 9(3) and (4)). Limitations on the technological and service neutrality must be only those objectively justified restrictions necessary to meet specified essential requirements (Article 9(3) and (4)). These are reflected in the proposed EECC in adapted Article 45, governing spectrum management, discussed previously.

[152] See Decision 243/2012/EU of the European Parliament and of the Council establishing a multi-annual radio spectrum policy programme (RSPP), 2010/0252 (COD), 15 February 2012. See text accompanying nn 153–158 below for a further discussion of the current programme.

Article 9b, Framework Directive requires spectrum transfers or leases for bands determined by the Commission under the implementing procedures, subject to continuing application of any attached conditions unless otherwise specified by the NRA. Other transfers and leases are permitted in other bands but not for uses not conforming to designated harmonized uses under the Radio Spectrum Decision. Proposed Article 51, EECC continues these provisions. How the above Member State discretion regarding continuing condition applicability and non-compulsory band transfer/leasing interacts with a new provision intended to ensure consistency and clarity, Article 51(3), is not clear. It states that 'Member States shall allow the transfer or lease of rights of use for radio spectrum where the original conditions attached to the rights of use are maintained.' Article 51(3) requires that Member States, without prejudice to the need to ensure undistorted competition, submit leasing/transfers to the least onerous procedure possible and, on notification by the lessor, not refuse the spectrum lease unless the lessor refuses to remain accountable for the original conditions and, on request by the parties, approve transfer of rights of use unless the transferee is unable to meet the original conditions for use. The competent authorities must facilitate leases/transfers by timely considering requests to adapt the conditions and by ensuring that the rights and the spectrum attached to those rights may best be partitioned or disaggregated. Under both the current and proposed frameworks, transfer/lease rights may be delimited where the original grant was not paid for.

Also related to the amorphous strategic planning and cooperation obligations is the provision for what is essentially secondary legislation by the Commission. In 2009, Article 9(3) (Framework Directive) authorized it to propose legislation for multiannual spectrum policy programmes taking utmost account of the Radio Spectrum Policy Group's opinion. Such legislation will specify the policy objectives for the relevant strategic planning and harmonization of the use of spectrum (arguably the substance of what the Member States are cooperating in/with/for) under the Framework and the specific Directives and the common policy objectives for coordinating EU interests at international bodies competent in spectrum matters. This purposive and significant planning programme appears to place much greater control over the direction of EU spectrum allocation and policy with the Commission, if not to the same level of the rejected supranational regulator of spectrum.

In pursuit of this agenda, the Commission in 2010 introduced a multi-annual spectrum policy programme, approved by the Council and the Parliament.[153] This

[153] Decision No 243/2012/EU establishing a multiannual radio spectrum policy programme, OJ L 81/7, 21 March 2012.

set the regulatory principles and policy objectives to be applied for various spectrum use determinations and other actions through 2015, that included:

- Ensuring that at least 1200 MHz spectrum are identified by the end of 2012 to meet the Digital Agenda's stated 30 Mbps target for wireless broadband in light of demand and that the need for additional harmonized spectrum bands is assessed;
- Allowing spectrum trading throughout the EU in all harmonized bands where flexible use has already been introduced;
- Making available sufficient harmonized spectrum for the development of the internal market for wireless safety services and civil protection;[154]
- Fostering different modes of spectrum sharing in Europe since there is great and still growing demand for these bands generally used in licence exempt WiFi access with core role in broadband mobile technologies;
- Ensuring that the radio spectrum can be used to support more efficient energy production and distribution in Europe with wireless promoting a low-carbon society;
- Finding appropriate spectrum for wireless microphones and cameras (PMSE);[155] and
- By mid-2013 defining details for the EU's radio spectrum inventory and an adequate analysis of the efficiency of spectrum use, particularly in the 400 MHz to 6 GHz range which inventory and analysis will serve as the basis for further harmonization and coordination in appropriate bands.[156]

The referenced EU spectrum inventory encompasses all existing public and commercial uses to permit identification of bands amenable to further EU-wide harmonization and reallocation (Article 9). It is viewed as a way to maintain a permanent, dynamic inventory of EU spectrum using the European Communications Office Frequency Information System (EFIS) so as to be able to identify technology trends, user demands, and needs as well as efficiency and impact of allocations.[157]

[154] 2016/687/EU Commission Implementing Decision on the harmonisation of the 694–790 MHz frequency band for terrestrial systems capable of providing wireless broadband electronic communications services and for flexible national use in the Union, OJ L 118/4, 4 May 2016 (harmonizing technical conditions for Public Protection and Disaster Relief use in various 700 MHz bands).

[155] 2014/641/EU Commission Implementing Decision on harmonised technical conditions of radio spectrum use by wireless audio programme making and special events equipment in the Union, OJ L 263/29, 3 September 2014.

[156] 2013/195/EU Commission Implementing Decision defining the practical arrangements, uniform formats and a methodology in relation to the radio spectrum inventory established by Decision No 243/2012/EU, OJ L 113/18, 25 April 2013.

[157] O'Donohue, P, Presentation, The Radio Spectrum Policy Programme & the Spectrum Inventory (ITU Regional Development Forum Warsaw, 7 May 2012).

The Decision further identified as a European priority the provision of harmonized spectrum for other EU wireless policies including space exploitation, earth monitoring, intelligent transport safety and management systems, Galileo civil navigation programmes, and academic and scientific initiatives with possible major socio-economic or investment impact (Article 8).[158]

As noted, the Commission's proposals in the EECC, premised on the technical harmonization processes and building on the duties of cooperation would allow various Commission implementing measures to harmonize further the Member State processes of spectrum allocation, allowing the Commission even greater control, as noted by BEREC.

Issues of control arise further in the 2012 Decision that also addresses principles for EU/Member State coordination and prioritization in connection with their respective representation with international bodies (Article 10) such as the duality in their roles as EU Member States and ITU members. It requires that there be an effort, under the principle of sincere cooperation, by the EU and the Member States to arrive at a common position where the matter involves overlapping competences. The Member States and the EU must cooperate in this situation according to the unity of international representation principle.[159] This means that, practically, a Member State could not submit any proposals or possibly take a position that is not compliant with those of the EU, even where not yet formally adopted.[160] The implementation of any bilateral or multilateral agreement by the Member State must be stated therein or in an accompanying declaration to be in accordance with EU treaties. A recent CJEU decision adds colour to the issue. It governs the legal form that Member States (ultimately as the members of the Council) must use for EU negotiation positions at the ITU and likely has practical implications not only for the balance of powers between the EU and individual Member States but also between EU institutions (in light of the Member States effectively comprising the Council). In *Commission v Council of the European Union*, the CJEU found that the Member States (acting on behalf of the EU as it is not a party to the ITU) had failed to adopt a formal Council 'decision' pursuant to Article 218(9), Treaty on the Functioning of the EU (TFEU), for the EU's negotiating positions on issues at the ITU's 2015 Radio Conference where there was no prior EU agreement on issues and ad hoc decisions might be required before Radio Regulation revisions at the Conference. The Council adopted, instead 'conclusions'. The Commission

[158] The Commission in 2014 issued a Report to the European Parliament and the Council on the implementation of the Radio Spectrum Policy Programme, COM/2014/0228 final where it noted that a final 2015 report on the particular programme would be forthcoming; the author is unable to locate this or a further proposed multiannual programme plan. It is difficult to track, therefore, the status of the various programme elements beyond the interim report in the absence of implementing decisions as noted.

[159] Decision, n 1 at Article 10(1).

[160] See Case C246/07, *Commission v Sweden* (20 April 2010).

contested this before the Court. The CJEU agreed with the Commission and found that these conclusions were not legal acts with the form required by the TFEU provision and did not indicate the legal basis that must underpin EU actions for them to have legal effect.[161] As the Court noted, the legal basis controls the powers of the Council and the Commission, here requiring a qualified majority on the part of the Council, for approval.[162] It is suggested that the practical significance of the decision is: enhanced influence for the Commission in WRC negotiations in light of its right of initiative; reduced influence and veto power for individual Member States in light of qualified majority Council voting and; generally reduced manoeuvring room in negotiations due to the requirement for formal, legally binding Council decisions.[163]

The outcome of the proposed EU Electronic Communication Code continues the tug of war as to institutional (and intra-institutional)[164] and Member State competences. The Council and the Parliament committees have adopted positions for the trilogue negotiations that are underway with a view to agreement in Spring 2018. Spectrum is clearly a key issue on the table.

7.6 THE UK SPECTRUM FRAMEWORK

In the UK spectrum use is regulated under the Wireless Telegraphy Act 2006 (WTA).[165] This Act combined into one statute the legislation under which Ofcom manages radio spectrum.[166] Coming into force on 8 February 2007, this Act replaced the Wireless Telegraphy Acts 1949, 1967, and 1998, the Marine, etc Broadcasting (Offences) Act 1967, Part 6 of the Telecommunications Act 1984, and certain provisions of the Communications Act 2003 regarding regulatory obligations with

[161] Case C-687/15, (25 October 2017), at paras 47–55. [162] Ibid, at para 51.

[163] Legal Case Note: '*CJEU Decision on EU Negotiation Positions in International Bodies*', (European, 18 December 2017).

[164] See reported comment by rapporteur Dita Charanzová, European Parliament Committee on the Internal Market and Consumer Protection (IMCO), that while the Committee on Industry, Research and Energy (ITRE) leads the Parliament negotiations, IMCO has 'exclusive competence' over one-third of the text, Internet Society, EU: Feedback on the negotiations on the European Electronic Communications Code (Internet Society European Regional Bureau Newsletter, 18–24 November), <https://www.internetsociety.org/resources/doc/2017/european-regional-bureau-newsletter-18-nov-24-nov-2017/>.

[165] Wireless Telegraphy Act 2006.

[166] Practical Law 'Wireless Telegraphy Act receives Royal Assent' (Thompson Reuters, 2006), <https://uk.practicallaw.thomsonreuters.com/4-205-7993?transitionType=Default&contextData=(sc.Default)&firstPage=true&bhcp=1>.

respect to the management of spectrum.[167] Parts of the Act have been amended to address the 2009 reforms and other subsequent changes.

7.6.1 The Act's scope and grant of powers

As with prior Acts, all persons must be licensed to install and or use radio equipment.[168] It is an offence[169] to do so unless the use is subject to an exception under the Act (s 8(3)) as specified in the Wireless Telegraphy (Exemption) Regulations 2003 as amended.[170] The Communications Act 2003 did not make major changes to the wireless telegraphy licensing regime but rather some adjustments to bring it into conformity with the 2002 EU Framework and the new UK regulatory structure, transferring the power to manage spectrum from, then, the Department of Business, Industry and Skills to Ofcom.[171] The 2009 EU reforms as well required only limited changes. Thus, with limited exceptions, the Wireless Telegraphy Act 2006 has exactly the same effect as the legislation it replaces, including various provisions of the Communications Act 2003. The powers and duties originally granted under the latter are now largely in the 2006 Act. The 2009 EU reforms that required further revisions to the Wireless Telegraphy Act 2006 and the Communications Act 2003 were primarily made by The Electronic Communications and Wireless Telegraphy Regulations 2011.[172]

[167] See Joint Committee on Consolidation of Bills, First Report of Session 2005–2006, Wireless Telegraphy Bill [HL], Vol II Minutes of Proceedings and Minutes of Evidence (House of Lords, House of Commons, London, 23 May 2006).

[168] See Radiocommunications Agency, 'Licensing Policy Manual' Section A: Impact of UK Legislation (Archived 12 July 2008), <http://webarchive.nationalarchives.gov.uk/20051027120000/http://www.ofcom.org.uk/static/archive/ra/rahome.htm>. The specific acts governed by these are 'to instal or use wireless telegraphy apparatus' and 'to establish or use a wireless telegraphy station.' WTA 2006, s 8(1)(a)–(b)). A licence under the Broadcast Act may also need to be obtained for certain TV and radio broadcasters.

[169] WTA (2006), at ss 8, 35(1). See *R v Blake* [1997] 1 Cr App R 209.

[170] SI 2003/74. The criteria for exemptions are discussed at text and accompanying nn 183–184. These are routinely amended and updated. See Ofcom, Wireless Telegraphy Exemption Regulations, <https://www.ofcom.org.uk/spectrum/radio-spectrum-and-the-law/licence-exempt-radio-use/wireless-telegraphy-regulations>. Also see, eg The Wireless Telegraphy (Exemption and Amendment) (Amendment) Regulations 2017, SI 2017/46 (amending the Wireless Telegraphy (Exemption and Amendment) Regulations 2010, SI 2010/2512 as amended by SI 2011/3035, SI 2013/1253, and SI 2014/1484). There would not seem to be an up-to-date summary list of exempt devices.

[171] The spectrum policy role was transferred from BIS to the Department for Culture, Media and Sport (DCMS) in January 2011. The Secretary of State has residual powers to consult on policy and make a direction or order, in consultation with Ofcom and other persons, concerning reserving spectrum for specified uses and licensing exemptions and charges. Communications Act 2003, ss 156, 157; Wireless Telegraphy Act 2006, ss 1–5. The government has exercised the former extensively. The ability to exercise the latter is questionable in light of recent case law. See text and accompanying nn 181–186.

[172] SI 2011/1210. Other EU reforms not generally involving spectrum were made via other instruments. Eg some minor amendments were made by The Electronic Communications (Universal Services) Amendment, SI 2011/1209 (eg removing any GC requirement from the scope of the USO). Another not so minor amendment was

7.6.2 Ofcom's spectrum management duties

Under the Act, Ofcom has the duty to develop and publish the UK Plan for Frequency Authorisation identifying what frequencies are allocated to a particular purpose[173] in the UK within the internationally agreed framework for spectrum allocation, ie the Radio Regulations of the International Telecommunication Union.[174] Before the plan is published, Ofcom must ensure that any allocation criteria for a particular purpose is objectively justifiable in relation to the frequency or its uses to which they relate, proportionate and transparent in relation to what they intend to achieve, and not unduly discriminate against a particular person or particular class of persons (WTA, s 2 (3)).

The Act sets out duties with respect to spectrum functions in section 3. It requires that Ofcom, in carrying out its radio spectrum functions, have regard to the extent to which electromagnetic spectrum is available for wireless telegraphy use, or further use and the current and likely future demand for spectrum (WTA, s 3(1)). It must also have regard to the objectives of promoting: efficient management and use; economic and other benefits that may derive from its use; innovative services and competition in electronic communications services (WTA, s 3 (2)), unless these are unrelated to the case or there is no obligation to consider these, apart from this section (WTA, s 4). Ofcom may not disregard these section 3 considerations, however, in the context of payment of sums for spectrum licence fees/rights of recognized spectrum access and may, in light of these considerations, prescribe sums greater than those necessary to recover costs incurred by Ofcom (WTA, ss 4, 13, 22). Any conflict between Ofcom's duty under section 3, WTA and its duties under sections 3–6 of the Communications Act 2003 (CA),[175] requires priority to be given to the latter (WTA, s 3 (5)).

The Act sets duties for the Secretary of State, as well, in executing the functions designated to him under the Act. The Act authorizes the Secretary of State to give general or specific directions to Ofcom concerning the carrying out of its radio spectrum functions. These can include directions to ensure that frequencies are kept or become available for specified uses/users (WTA, s 5(2)). Where the order governs licence exempt use (s 8(3)), payment for licences and recognized grants

made by The Communications Act 2003 (Maximum Penalty for Contravention of Information Requirements), SI 2011/1773 (increasing the maximum penalty to £2,000,000 from £50,000).

[173] WTA, s 2. Ofcom must also publish as part of the plan, what spectrum is available and whether these can be traded. Ibid. The Plan is online at <http://spectruminfo.ofcom.org.uk/spectrumInfo/>.

[174] See also Chapter 16.

[175] These Communications Act duties include: s 3, General Duties; s 4, Duties for the purpose of fulfilling Community obligations (implementing Art 8, Framework Directive); s 5, Directions in respect of networks and spectrum functions and; s 6, Duties to review regulatory burdens.

of access, including by bid (ss 12–14, ss 21–23), the Secretary of State may require Ofcom to exercise their powers in such cases, in such manner, subject to such restrictions and constraints, and with a view to achieving such purposes as is specified in the order (WTA, s 8(3), (4)).

All of these duties were the subject of a recent Court of Appeal decision, *EE Ltd v Ofcom*.[176] Here the Court found that Ofcom, following the Secretary of State's 2010 Direction[177] set Annual Licence Fees in 2015 to reflect the market value for the 900 MHz and 1800 MHz spectrum bands (liberalized for other uses by, inter alia, the EU repeal of the GSM Directive) that it had reallocated to existing users also pursuant to the Direction for an indefinite period and varied their licences accordingly. In doing so, therefore, Ofcom had failed to exercise its Article 8, Framework Directive obligations required to be performed by it in carrying out its radio spectrum functions by both section 4(1) and (2), CA and section 5(3), WTA.[178] While WTA, section 5 (1), and 5(3) and (4) authorize the Secretary of State to direct Ofcom in performing its spectrum functions to exercise its power in such manner as the Secretary may specify and subject to such restrictions and constraints, with a view to achieving the purposes specified in the Order,[179] the Court found that nothing in the WTA or the Communications Act transferred that power to the Secretary of State or allowed Ofcom to delegate to the Secretary its duties under section 4(2) 'to act in accordance with the six Community objectives (which give effect, amongst other things, to the requirements of Article 8 of the Framework Directive and are to be read accordingly)'.[180] Thus, the 2010 Direction could not have this effect. Therefore, as the duties remained with Ofcom, in following the Direction it failed to meet its duties under both Acts and the Framework Directive.[181]

The outcome of this decision is not yet clear as the Court of Appeal has given Ofcom leave to appeal. Practically speaking, the decision effectively renders the power of the Secretary to give directions meaningless. Although the Court of Appeal bent over backwards to find that the Direction itself was not ultra vires, the fact is that the Direction itself was not challenged. Rather, only the 2015 annual fee decision by Ofcom. Had the other Ofcom acts pursuant to the Direction

[176] [2017] EWCA Civ 1873, at para 54.

[177] Wireless Telegraphy Act 2006 (Directions to OFCOM) Order 2010, SI 2010/3024.

[178] [2017] EWCA Civ 1873, para 54.

[179] The speedy reallocation of the liberalized spectrum to 3G use to avoid delay likely via the regulatory process and the litigation challenges thereto likely, no matter the outcome. Ibid, para 47.

[180] Ibid, para 19.

[181] Indeed, the Court found that WTA, s 3(5) gave priority to the CA, s 4(2) duties (Art 8, Framework Directive duties) in the event of a conflict with Ofcom's WTA, s 3 powers.

been subject to the same analysis as here (reallocating the spectrum to the same users and making them indefinite), Ofcom would have had to follow its full regulatory processes of consulting and making a decision in light of the merits of the Article 8 considerations that these actions were warranted as meeting the objectives. A Secretary of State's order regarding issues with the EU framework would,[182] therefore, always seem a moot act subject to Ofcom's review under Article 8 as these apply across the board to all regulatory functions, calling the CA and WTA provisions into question.

The WTA mandates the use of spectrum without licence[183] where the conditions of the use are unlikely to:

- have an adverse effect on technical quality of service;
- lead to inefficient use of the part of the electromagnetic spectrum available for wireless telegraphy;
- endanger safety of life;
- prejudice the promotion of social, regional, or territorial cohesion; or
- prejudice promotion of cultural and linguistic diversity and media pluralism (WTA 2006 s 8(3), (4), and (5)).

Here, conditions, if any, may only be those permitted under Annex A, Authorisation Directive (s 8(3A)), ie general authorization conditions. Included within exempt use are, eg terminal equipment for GSM, UMTS, and now LTE and WIMAX (technologies for 4G services).[184]

Where a licence is granted it may be subject to conditions or limitations (WTA, s 9). While the Act states that these can be any kind Ofcom deem fit, a 2011 revision limits these to areas specified in Annex B of the Authorisation Directive (WTA, s 9(1A)).[185] If the condition limits technological neutrality, the nature of the

[182] Not all directions might concern such issues. Eg Ofcom notes that a grant of recognized spectrum access could be revoked immediately under a WTA, s 5 Direction. As this is regulation outside the framework except for the application of the Radio Equipment Directive, the Art 8 duties would not apply. See Procedures Manual for Recognised Spectrum Access for Receive Only Earth Stations (Ofcom, July 2017).

[183] WTA, s 8. Ofcom has committed to exempting spectrum whenever possible. See Ofcom, 'Licensing Exemption', Licensing Policy Manual, 2007, <http://www.ofcom.org.uk/radiocomms/ifi/licensing_policy_manual_2/>.

[184] See eg Wireless Telegraphy (Exemption) (Amendment) Regulations 2011. Also see, Ofcom, Licence Exempt Radio Use, <http://stakeholders.ofcom.org.uk/spectrum/spectrum-management/licence-exempt-radio-use/>.

[185] Annex B, Authorisation Directive comprises a nine-item list of the types of conditions that can be imposed on the use of spectrum. These include conditions regarding usage fees; technical/operational conditions necessary for safe, non-interfering use if different from general authorization obligations; effective and efficient use; maximum duration; transfer of rights; undertakings made in the course of a comparative/competitive process to obtain the spectrum; obligations to provide a service or use a technology for which the right to use the spectrum was granted, including coverage/quality requirements where appropriate; obligations

service or the type of equipment that can be used, it can be imposed only where justified by the essential requirements and general interest objectives set forth in section 9ZA, that comprise:

- avoiding undue interference with wireless telegraphy;
- the protection of public health against electromagnetic fields;
- ensuring technical quality of service;
- ensuring maximization of frequency sharing;
- safeguarding the efficient management and use of the part of the electromagnetic spectrum available for wireless telegraphy;
- ensuring fulfilment of a general interest objective as defined as in section 8B(3) (governing the criteria for an exclusive licence) that includes:
  - o safety of life;
  - o promotion of social, regional, or territorial cohesion;
  - o avoidance of inefficient use of frequencies;
  - o promotion of cultural and linguistic diversity and media pluralism;
  - o fulfilment of an ITU Radio Regulation requirement.

These implemented the 2009 reforms to the Directive and reflect its layers of safety/efficiency/international requirements. A review is required for licences granted for longer than ten years with non-transferrable individual conditions to determine whether they meet the section 8 exemption criteria, so as to make it eligible not to be subject to the requirement for a licence (WTA, s 8A).

A decision to grant a licence for exclusive rights to use a frequency, nationally or otherwise, may not be made by Ofcom except where necessary to protect safety of life services or other exceptional circumstances exist that Ofcom believes justify the exclusive grant to ensure a general interest objective, as above listed. Where the limitation has a significant impact on the market for the use of electromagnetic spectrum for wireless telegraphy, Ofcom must consult and publish a notice of its intention to limit a grant, specifying the reasons why and the period for which representations can be made to Ofcom, but that can be no less than a month (WTA, s 8C).

Limitations of either kind must be reviewed for continuing necessity with the consultation outcome published (WTA, ss 8B(5); 9ZA(7)). The review/publication requirements do not apply in the context of technology/service limitation where the user can opt for a different spectrum frequency without the limitation (WTA, 9ZA(8)). The precise interaction with the section 8A review for licences and

under international agreements governing frequencies; and obligations specific to experimental use of a frequency. See Annex B, Directive 2002/20/EC as amended by Directive 2009/140/EC.

non-transferrable conditions of more than ten-year duration for possible exemption is not clear.

How the section 8A unique licensing provisions practically relate to section 29 of the WTA 2006 is also not precisely clear. Section 29 is intended to implement Article 7(1)(c) of the Authorisation Directive as amended in 2009. This requires that where a Member State is considering whether to limit the number of rights of use to be granted for radio frequencies, it publish any decision to limit the granting of rights of use, stating the reasons. In keeping with Article 5(5) of the Directive, section 29 states that it applies to situations where Ofcom considers 'it appropriate to impose limitations on the use of particular frequencies for the purpose of securing the efficient use of the electromagnetic spectrum'. Spectral efficiency suggests this is only where limited numbers of users can utilize certain frequencies due to the spectrum's inability to support more users without interference. As the section 8A exclusive use decision can apply for general objectives like cultural diversity or social cohesion as well as efficient use of spectrum, whether section 29 applies at all or only in the last instance is unknown.

Section 29 requires Ofcom to issue an 'order' and publish the criteria it will use to determine the number of available licences and the category of persons to whom they will be made available.[186] The criteria must also be objectively justified, proportionate to the use, objective, and non-discriminatory in keeping with the requirements of the Framework Directive. Efficiency, or scarcity practically speaking, is likely to mean specific band or pairs of bands that must be allocated nationally or regionally in a way so as to avoid interference. The likelihood exists that scarcity could be co-extensive with exclusive use in some instances where other interference-ameliorating conditions will not suffice such as spectrum masks, filters, or smart technologies such as 'listen before you speak' transmitters, etc. However, the section 29 requirements may just apply where multiple but limited numbers of users can share the same spectrum bands, perhaps with priorities or other rationalizing conditions to manage interference.[187]

7.6.3 Grants of recognized spectrum access

The 2003 reforms provided for a 'grant of recognized spectrum access', now in section 18 of the WTA 2006. Persons using radio equipment (a station or apparatus)

[186] WTA, s 29. See also, The Wireless Telegraphy (Limitation of Number of Licences) (Amendment) Order 2006, SI 2006/2786 (as further amended).

[187] See eg The Wireless Telegraphy (Licence Award) Regulations 2012, SI 2012/2817 specifying the criteria for the 800 MHz and 2.6G band awards, cohesive draft Regulation, <https://www.ofcom.org.uk/__data/assets/pdf_file/0016/41344/condoc.pdf/>.

where a licence is not required but where transmissions occur within the UK may apply for such grant. Ofcom is to consider an RSA to the same extent as it would consider an existing licence when it allocates spectrum (WTA, s 20). Ofcom indicated its intent to limit interference with uses and areas covered by RSAs, as it would with licensed grants.[188] The RSA may be given for any use and equipment specified in the grant and subject to any conditions that Ofcom may consider appropriate,[189] including for strength of signal and equipment, but cannot duplicate any conditions that are already imposed under general conditions. RSA grants may be converted to a licence or a licence to a grant.[190]

That RSA conditions could be also imposed under a general condition indicates that the Act here contemplates an exempt or similar use in the nature of a general authorization and where the exempt user might wish to preserve the use for future allocation. A grant effectively reserving a particular usage could be sought by government agencies[191] whose spectrum use is currently largely 'licensed' only by a voluntary agreement called a 'side letter'.[192] It may also be sought by providers of networks using equipment that is exempt from licensing, as its risk of harmful interference is small, such as WiFi.[193] Radio astronomy was identified as a use where RSAs could be valuable to help limit interference. In 2007, Ofcom issued regulations for the granting of RSAs in connection with radio astronomy uses in existing bands and in the six locations where presently carried out.[194]

The Act also contemplates RSAs for uses unlicensed as they are outside the reach of the Wireless Telegraphy Act. The references to emissions from outside the UK (s 159(1)) as well as the use of a 'station' suggests a 'receiving only' earth station operator which although outside of licensing jurisdiction under the Act,[195] might wish to ensure continued frequency availability and interference minimization. Ofcom

[188] Ofcom Statement, 'Spectrum framework review for the public sector: Extending market mechanisms to improve how spectrum is managed and used', 31 January 2008, s 2.8.

[189] RSAs and conditions could not, however, constrain the uses of public sector agencies, such as the Ministry of Defence. See Ofcom Consultation, 'Spectrum framework review for the public sector: Notice of Ofcom's Proposal to make regulations on Recognized Spectrum Access for public bodies and consultation on technical conditions', 20 June 2008, s 4.7.

[190] WTA, s 27.

[191] This is limited to Crown bodies. That the Act contemplates this purpose for RSA is reinforced by the authorization to Crown agencies to pay for, inter alia, recognized grants of spectrum use. See WTA, s 28.

[192] This would seem a fairly unique UK example of a contract for a licence. See Ofcom Licensing Policy Manual, 'Authorisation of radio use for Crown bodies', 2007, <http://www.ofcom.org.uk/radiocomms/ifi/licensing_policy_manual_2/crown>.

[193] Ofcom Licensing Policy Manual, 'Licence exemption', 2004.

[194] Ofcom, 'Statement on regulations for recognised spectrum access as applied to radio astronomy', 28 February 2007.

[195] See eg 'Procedures manual for recognised spectrum access for receive only Earth stations', July 2017, <https://www.ofcom.org.uk/manage-your-licence/radiocommunication-licences/satellite-earth/earth-stations>.

has promulgated regulations providing for RSAs, their conditions, charging, and trading in connection with 'receive only' earth stations used for fixed satellite or meteorological satellite services in certain bands, noting that the scheme remains voluntary.[196] With RSAs, conditions would be imposed only under the grant notification procedures.

RSAs may have a charge, including one determined by auction.[197] RSA charging regulations provide that these can vary according to the nature of the use and the frequency bands involved.[198] With radio astronomy, Ofcom determined that Administrative Incentive Pricing (AIP) based on the opportunity cost of denying the spectrum to alternative services, eg broadcasting, was appropriate.[199] With Receive Only Earth Stations, Ofcom has set an annual £500 plus a calculation based on a rate charge for the bandwidth involved.[200] The fee applies to a single REOS or all REOS within 500 metres.

The Wireless Telegraphy (Register) (Amendment) Regulations 2007 provided for the inclusion of RSA grants in the registry created by Ofcom to enable spectrum trading.[201] As public entities hold a significant allocation of spectrum estimated to have a value of over £20 billion, Ofcom was seeking ways to improve its management and efficient use, including by trading and licensing of traded RSAs where possible.[202] The latter is required as RSA eligibility often derives from the non-licence status of the user as a public agency. Therefore use by another undertaking would not be subject to an RSA and would have to be licensed. Starting in 2007, Ofcom consulted on RSA tradability by public sector entities.[203] In 2009, it adopted regulations to permit trading of an RSA or conversion to a licence or from a licence to an RSA, both where either all of the rights and obligations are transferred

[196] Ofcom, 'Decision to make Regulations for Recognised Spectrum Access (RSA) for receive only Earth stations in the bands 1690–1710 MHz, 3600–4200 MHz and 7750–7850 MHz', 30 November 2011.

[197] WTA, ss 21, 23.

[198] The Wireless Telegraphy (Recognised Spectrum Access Charges) Regulations 2007, SI 2007/392 as amended by The Wireless Telegraphy (Recognised Spectrum Access Charges) (Amendment) Regulations 2011, SI 2011/2762, The Wireless Telegraphy (Recognised Spectrum Access Charges) (Amendment) Regulations 2015, SI 2015/1399.

[199] See Ofcom Consultation, 'Notice of Ofcom's proposal to make regulations for Recognised Spectrum Access (RSA) for radio astronomy', 10 November 2006, ss 5.38–5.60.

[200] The Wireless Telegraphy (Recognised Spectrum Access Charges) (Amendment) Regulations 2015, SI 2015/1399; Ofcom, Fees for Grant of RSA for ROES (2015), <https://www.ofcom.org.uk/__data/assets/pdf_file/0038/66899/fees_for_grant_of_rsa_for_roes.pdf>.

[201] The Wireless Telegraphy (Recognised Spectrum Access and Licence) (Trading Regulations) 2009, as amended (the 'RSA Trading Regulations').

[202] Ibid.

[203] See Ofcom Consultation, 'Spectrum framework review for the public sector: Notice of Ofcom's proposal to make regulations on Recognized Spectrum Access for public bodies and consultation on technical conditions', 20 June 2008); Ofcom Consultation, 'Crown Recognised Spectrum Access in the 3400 MHz -3600 MHz', 17 December 2011.

(surrendered to Ofcom which then issues a new RSA/licence) or they remain concurrent.[204] The RSA Trading Regulations also allow for partition of spectrum or geographically. Various transactions have resulted, enabling public bodies such as the Ministry of Defence that holds 75 per cent of the public spectrum to share frequencies for other uses.[205]

7.6.4 Spectrum auction and trading: market mechanisms and liberalization

The power to use auctions to allocate spectrum licences[206] was introduced by the Wireless Telegraphy Act 1998.[207] Section 14 of the WTA 2006 permits Ofcom to set the regulations for the auctions of licences, including the procedures, payment method, the need for a deposit and the terms, provisions, and limitations to which the licence would be subject.[208] These permit possible flexibility for different payment methods, including by instalments,[209] an option that Ofcom has elected not to pursue.

Ofcom has struggled to develop regulations for significant spectrum auctions in light of industry challenges. These have included not only spectrum for '3G' and '4G' spectrum uses, now largely allocated but also the '5G' auction that Ofcom has been trying to get off the ground since at least 2015. As previously noted, in 2005 Ofcom began consulting on 2G spectrum in the 900 and 1800 MHz bands that were being liberalized for uses other than 2G with a view to auctioning it. After repeated rounds of consulting on possible auction structure and whether to reserve bands for other users that had not originally been allocated that spectrum which the relevant operators threatened repeatedly to challenge in court, the government took the matter out of Ofcom's hands and ordered it to allow the existing users to refarm it for 3G uses and to vary their licences for such uses, as previously discussed. The Direction ordering that Ofcom establish annual fees for the spectrum that reflect market value is still the subject of litigation, with Ofcom having

[204] The Wireless Telegraphy (Recognised Spectrum Access and Licence) (Trading Regulations) 2009, SI 2009/17, as amended (the 'RSA Trading Regulations').

[205] Ofcom Consultation, 'Crown Recognised Spectrum Access in the 3400 MHz–3600 MHz', 17 December 2011.

[206] RSAs can now be auctioned as well.

[207] Wireless Telegraphy Act 1998, s 3, ch 6.

[208] See eg Ofcom's efforts to make regulations for the auction of spectrum in the 2.3 and 3.4 GHz bands in the face of Three's continuing legal challenge to the overarching spectrum caps the Ofcom has imposed for the auction. Ofcom, 'Notice of intent to make regulations: auction of spectrum in the 2.3 and 3.4 GHz bands', 17 January 2018, <https://www.ofcom.org.uk/spectrum/spectrum-management/spectrum-awards/awards-in-progress/2-3-and-3-4-ghz-auction>.

[209] Communications Act 2003, s 167.

been given the right to appeal to the Supreme Court from the Court of Appeal's decision in *EE Ltd v Ofcom*.[210]

The '4G' auction comprising the 800 MHz spectrum digital dividend and 2.6 GHz and labelled by Ofcom as the 'largest ever' UK single auction of 'internationally harmonized mobile spectrum' was also plagued with delays.[211] Ofcom had difficulty deciding whether and how the prime, low frequency 800 MHz bandwidth should be reserved for bidders other than O2 and Vodafone, both 2G licensees who were eventually allowed to use their 2G 900 MHz band spectrum that they were given (originally for nothing) for refarmed 3G use at lower fees than other 3G spectrum went for at auction. Below 1 GHz, spectrum is considered to have potentially lower network roll-out and operating costs due to its propagation characteristics, described earlier, requiring fewer base stations, lower power, less backhaul, etc. The potential other bidders, Hutchinson 3(3) and Everything, Everywhere (Orange and T-Mobile (Deutsche Telekom) (EE)), the UK's other national mobile providers who did not hold any UK 'sub 1 GHz' spectrum, contended that the promotion of competition, a Framework regulatory objective, required that either they should have allocations reserved for their bidding or that caps should apply to the amount of spectrum that the others could acquire.[212]

Possibly to avoid the litigation hinted at in 'veiled threats' by O2 and Vodafone if the rules were not changed,[213] Ofcom removed the reservation of sub-1 GHz spectrum for EE, the nation's largest network. In early March 2012, Ofcom notified that it proposed to grant EE's petition to refarm in 2012 its existing 1800 MHz spectrum to LTE and WiMAX usage. Ofcom indicated in the Notice that it did not consider the licence variation to distort competition in light of the nascent state of the market and the availability to other operators of the 2 x 15 MHz of 1800 MHz spectrum that EE was required to sell as a condition for EU approval of the merger of T-Mobile and Orange to create EE. Ofcom had earlier concluded that there would only be a small difference in EE's ability to deliver a comparable 4G product with the large amount of 1800 MHz spectrum that it already held for 2G and a network with more base stations.[214] Ofcom varied EE's licence to permit 4G use before the

[210] See text and accompanying notes 176–181.

[211] Ofcom, 'Second Consultation on assessment of future mobile competition and proposals for the award of 800 MHz and 2.6 GHz spectrum and related issues', 12 January 2012.

[212] See Garside, J, '4G Spectrum Auction: Time for the Networks to Grow Up' (Technology Blog, *The Guardian*, 11 October 2011), <http://www.guardian.co.uk/technology/blog/2011/oct/11/4g-spectrum-auction>.

[213] See Garside, J, 'London Becomes 4G High Speed Internet Hot Spot' (*The Guardian*, 13 November 2011), <http://www.guardian.co.uk/business/2011/nov/13/4g-high-speed-mobile-internet-trial-in-london?INTCMP=ILCNETTXT3487>.

[214] See Second Consultation, n 211, at 1.24.

800 MHz auction.[215] Although the other mobile operators argued that this gave EE an unfair advantage (ultimately less than seven months) in the 4G market, [216] they did not further challenge the decision when Ofcom agreed to advance the auction so that the other operators could launch their 4G offers by early summer 2013.

The 800 MHz auction regulation did reserve sufficient spectrum to ensure a fourth national wholesaler, ultimately Hutchinson, Three's parent. Ofcom proposed a special condition for one block of 2 x 10MHz bands to be imposed on one national provider to provide coverage to 98 per cent of the country by 2017 inclusive of 'not spot' areas for which Ofcom had £150 million designated for infrastructure, assuming that others would seek to compete with their network roll-outs. Vodafone acquired this block.

Litigation challenges also delayed Ofcom's auction of spectrum in the 2.3 GHz–3.4 GHz spectrum bands valuable for, respectively, current 4G uses and future '5G' uses (both freed up by the Ministry of Defence for non-military use in keeping with a government initiative to make available 500 MHz of spectrum by 2020). The April 2018 auction made available 190 MHz of spectrum, 40MHz in the 2.3 GHz band, all acquired by O2 and 150 MHz in the 3.4 MHz band, awarded to Vodaphone, O2, EE, and Three who acquired respectively 50, 40, 40, and 20 MHz each of this 5G spectrum for a total auction spend of over £1.4 billion. In a second set of auctions, targeted for 2020, Ofcom will make available spectrum in the 700 MHz band that the government plans to clear from digital terrestrial use,[217] moving it to 470–690 MHz bands and from wireless microphones. Ofcom also plans to auction 116 Mhz of spectrum in the 3.6GHz–3.8GHz bands, that will be available for 5G use seemingly alongside its current use for fixed links and satellite services.

The first auction originally intended for 2016 was delayed by the O2's proposed merger with Three, rejected by the Commission. Rescheduled for late 2017, in its July 2017 Decision, Ofcom imposed layered spectrum caps to foster competition in the market in light of the current spectrum holdings of the providers. It capped

[215] Ofcom, 'Notice of Proposed Variation of Everything Everywhere's 1800 MHz spectrum licences to allow use of LTE and WiMAX technologies', 13 March 2012, at 4.30.

[216] See Webster, A, 'UK Regulators delay Orange/T-Mobile LTE plan, give competitors time to react' (The Verge, 27 March 2012), <http://www.theverge.com/2012/3/27/2905627/ofcom-delays-everything-everywhere-lte-network/in/2671145>.

[217] The same challenges faced decisions to make this available. The 600 MHz frequency is the lower part of the digital dividend. The decision to move Digital Terrestrial Television (DTT) down to the 600 MHz band from the 700 MHz band where it is currently operating was considered to be the most beneficial since there is an emergent international trend to harmonize this frequency for this use with a proposal tabled for this at the ITU 2015 conference with the US, Africa, and parts of Asia rolling out LTE in this band. This would promote international interoperability and economies of scope for consumers in terminal equipment. At the same time, however, the 600 MHz band will not be harmonized for DTT with possible ensuing costs for television receiving equipment.

the amount of overall spectrum holding post-auctions by any one provider to 340 MHz (or 37 per cent share with the added spectrum) and immediately usable spectrum post-auction to no more than 255 MHz. EE and Three, for different reasons, challenged these in court. The immediate use cap meant that EE could not bid for spectrum in the 2.3 GHz band with its current possible 4G use. BT's acquisition of EE gave it a combined pre-auction holding of 45 per cent of total spectrum, meaning that its auction bid for future use 3.4 MHz was limited to a maximum of 85 MHz. Vodaphone could acquire no more than 160MHz in both auctions but O2 and Three would have no caps.

Three objected to the 37 per cent cap, arguing that it should be lowered to 30 per cent. BT/EE objected to any caps and the phased implementation, or contiguity, of 5G spectrum auctions, contending that spectrum in all relevant bands for 5G use should be combined into a single auction. The High Court found for Ofcom[218] but granted Three leave to appeal to the Court of Appeal that it rejected on an expedited basis, allowing the auctions to proceed.

Ofcom's role is not to be envied. In awarding spectrum, it must anticipate the long-term technological possibilities (while remaining technologically neutral where possible), yet also deal with the short-term reality while coordinating with the EU and possibly internationally for the medium term, all pursuant to legal and procedural obligations. Even where it seeks to consider all of these required relevant and very complex factors, it faces legal challenge. When it follows government direction, it faces legal challenge. At the same time, the providers' challenges are understandable. Decisions now could serve to preserve their interests for decades. Their objections to novel ways of proceeding to allow for future developments as rules and frameworks evolve mean that the spectrum regulatory landscape is likely to be fraught with uncertainty and future legal challenges to stop or slow down regulatory developments that they do not like and lobbying in the press and the political arena to bring pressure on the regulator to backpedal after having reached a reasoned, if not perfect, decision based on competition, social policy, and technological considerations.

One area, however, where the industry participants appear to have worked together more fruitfully in recent years involves another market liberalizing effort, the trading and leasing of spectrum. The 2003 Act authorized spectrum trading (s 168).[219] With the Wireless Telegraphy (Spectrum Trading) Regulations 2004, Ofcom began a phased implementation of spectrum trading combined with a programme of increasing liberalization of spectrum via de-licensing bands and/or

[218] *Hutchinson 3G v Ofcom* [2017] EWHC 3376 (Admin).
[219] Repealed and replaced by the WTA, s 30.

uses of compliant equipment as well as the removal of conditions specifying uses so that traded spectrum can be put to new uses.[220] However, it was considered that the spectrum trading as implemented with requirements for consent, publication, and new licence issuance was not really effective and likely comprised a barrier to trading to the detriment of consumers and other persons. Following adoption of the 2009 reforms, Ofcom consulted and determined to simplify the secondary market mechanisms that now include both leasing and transfers, collectively called 'spectrum trading' by Ofcom. Transfers comprise the exchange of all or part of licence rights and associated obligations to another party that can generally be outright (no residual rights) or concurrent (rights and obligations shared concurrently and fully with respect to the spectrum at issue) with some licences subject to limitations.[221] Depending on the extent of the transfer, Ofcom will either revoke or vary the original holder's licence and issue a new licence to the transferee. The transfer can be permanent or time-limited, the latter requiring that the transferee must reverse the transfer at the end of the period. Ofcom consent is no longer to be required for transfers of most licence classes to which the right to transfer applies, subject to the promulgation of regulations enabling this change.[222] Other spectrum transfers, notably those of public network operators, will continue to require consent in order for Ofcom to be able *ex ante* to assess the competitive impact, an obligation of the Authorisation Directive.[223] For all trading, the spectrum price is subject to commercial negotiations.

Spectrum leasing, both total and partial, and one level of sub-leasing is possible under fairly simple contractual processes for most auctioned spectrum and other business class spectrum licences. Until the licence provides for leasing, a variation must be sought upon application.[224] The lease can be for the full term of the licence or a part thereof. It is the licensee/lessor who remains responsible for all obligation compliance, including payment, and who are expected to be responsive to complaints. Which Ofcom will proceed against regarding any breach will depend on the circumstances. Ofcom notes that it is required to act reasonably and proportionately and will consider whether the licensee could have done more or contributed to the breach in determining whether to hold it accountable.[225] Therefore, lease agreements should address the necessary payment obligations and make appropriate provisions for liability and possible indemnification, including legal fees. Ofcom is still proceeding a bit cautiously in implementing this. The necessary regulations to withdraw the requirement for the variation and publication

[220] Ofcom Statement, 'A Statement on spectrum trading: Implementation in 2004 and beyond', 6 August 2004.
[221] See Ofcom, 'Trading Guidance Notes', July 2015, at 1. [222] Ibid.
[223] The Wireless Telegraphy (Mobile Spectrum Trading) Regulations 2011, SI 2011/1507, at s 8.
[224] Trading Guidance Notes, n 221 at Table 4. [225] Ibid, at s 3.

were promised when it was convenient for Ofcom to do so, but have not yet been done. Ofcom possibly wishes to continue to observe some actual developments to take into consideration. This would likely need to be done in the event that the proposed EU reforms requiring the least onerous regime are implemented. Ofcom has, however, established a Spectrum Trading desk to facilitate these.

Exceptions to the ability to trade spectrum include failure to pay the charges for the licence and also where Ofcom has not yet made a requested variation or revocation of the licence.[226] Ofcom can refuse consent for a transfer where necessary in the interests of national security, compliance with EU and international obligations, or pursuant to an order of the Secretary of State under the Communications Act 2003's spectrum policy powers under sections 5 and 156.[227]

7.7 CONCLUDING REMARKS

The mobile age is as exciting today as it was in 1901 when the new wireless achievements led a London newspaper to conjecture that people would someday carry their wireless telephones with them.[228] It took almost ninety years for that to become an almost global reality. The inventions that lie at the heart of today's mobile devices have their roots in scientific achievement that spans two centuries. Whether 100 years from now, someone marvels at their cochlear 'brainplants' that allow them to 'hear' from anyone or anything, everywhere, must be left to imagination. However, if the Commission's vision is any indicator, with spectrum to be allocated for the Internet of Things and new science,[229] we cannot rule it out.

The law is often in a catch-up mode. Sea changes in technologies and market trends will occur with regulation needing to react. The regulator as 'seer' is part of today's job description. The benefit of such expertise and vision can be witnessed in a number of the EU's early decisions to mandate a harmonized EU standard for mobile communications. The GSM Directive allowed for the quick roll-out and take-up of wireless communications technology with providers, manufacturers, and ultimately end users able to benefit from the derived economies of scale and certainty about interoperability and technical specifications. This view is not

[226] See Statement, n 220, at s 7.

[227] The Wireless Telegraphy (Mobile Spectrum Trading) Regulations 2011, s 8(5).

[228] White, TH, 'United States Early Radio History: Personal Communications by Wireless (1879–1922) (noting 4 November 1901, Los Angeles Times, at 6, quotation of London Spectator: 'Some day men and women will carry wireless telephones as today we carry a card case or camera'), <http://earlyradiohistory.us/1901age.htm>.

[229] See Decision, n 8.

universal,[230] and perhaps, in light of the intransigence of mobile rates, NGN roll-out delays, and other spectrum bottlenecks in the EU which have caused and continue to cause the Commission to seek new regulatory powers, it is not deserved.

However, not every regulator's decoder ring always receives across all frequencies and sometimes seers do not have 20/10 vision. Although not perfect, the EU legal infrastructure in place to analyse and agree standards for mutual implementation of spectrum management has been workable. The review and proposed reforms are a good thing if only to step back and take a look at what is needed for future developments and what is working well enough in light of possible alternatives.

Spectrum regulation is a truly complex exercise. The allocation of these significant blocks of spectrum are decisions with potential impact for generations, and require engineering and economic expertise and the administrative ability to meet all the policy objectives that must be mashed into the market mechanism the regulator must use for decisions that, ultimately, will not make everyone happy. How the proposed reforms shake out in 2018 are not likely to make everyone happy either.

[230] See Sutherland, E, Paper: 'European Spectrum Management: Successes, Failures & Lessons' (ITU Workshop on Market Mechanisms for Spectrum Management Geneva 22–23 January 2007). Sutherland, however, does not seem to question the GSM Directive itself but the lack of sufficient competition introduced at the time continuing to today with a further failure to anticipate the high pricing issues and the disadvantage fixed networks had in termination rates.