Advantages of Licence-Exempt Spectrum:

Allocation Versus Auctions for upper 6GHz Spectrum

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Abstract: This paper examines the relative advantages of allocating spectrum by auction or without licensing. The debate over how to allocate the spectrum will at times rest fundamentally on the challenges of choosing between alternative technologies. This paper notes that economic benefits of a highly distributed and non-excludable technology, like Wi-Fi, may be higher than for an excludable technology, like mobile data, but that the bidding capacities of each technology can easily sway towards an excludable technology due to a highly distributed technology's inability to appropriate gains and thus to reflect its underlying social gains in bids. This argument is developed specifically with respect to the upper 6 GHz band of spectrum. The paper argues that reserving this band as unlicensed spectrum would plausibly deliver higher social surplus, higher economic value to government and reduced user costs compared to allocating the band via auction.

Keywords: auctions, spectrum, allocation, licensing

JEL Codes: D44, D45, L59, L86, L96

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1. Introduction

1.1. This paper considers the appropriateness of auctions or administrative allocation of spectrum that is particularly well suited to Wi-Fi and its use indoors. The paper suggests that, even if auctions are often desirable for allocation of spectrum, there are many reasons to maintain licence-exempt spectrum[1] for certain types of technology. One of those types of technology is Wi-Fi and one of the appropriate frequency bands for this technology is the upper 6GHz (U6) range of spectrum.

1.2. The question of whether auctions are the preferred mechanism of allocating such spectrum is a matter of debate. Near-term decisions will determine the long-term usage and allocation of that spectrum. Some well-respected observers suggest the spectrum should be auctioned as a matter of principle. This paper argues that, particularly for the Wi-Fi use case and the economic context of this case, an allocation of the licence-exempt spectrum may be most appropriate. The reason is that auctions will not always allocate spectrum to its most highly valued activity by society and that Wi-Fi as a whole is particularly likely to experience difficulty assembling a bid that approximates or duly reflects the aggregate end-user values (or social value).

1.3. Auctions are most appropriate for spectrum when there is a risk of interference between different mobile operators who are competing to use the same spectrum. Wi-Fi has managed to develop a technology solution that is designed to enable coexistence between different Wi-Fi devices. In such a case, where a technology is designed to allow shared use of the medium, auctions are not needed to promote efficiency between Wi-Fi users (or between Wi-Fi and other users such as satellite operators)[2]. In contrast, if different mobile operators were using the same spectrum there would be interference challenges.

1.4. Wi-Fi and mobile typically cannot occupy the same spectrum without interference and, as a consequence, authorities are asked to choose between them[3]. Auctions are not the best mechanism for allocating spectrum between the two technologies. The reason is that Wi-Fi spectrum is used by a wide community of users, who would have difficulty to coordinate over bidding and who would not be able to identify highest value hardware producers or private users in advance, where the usage requires innovation, and thus would not be likely to bid the expected long-run value of the spectrum. Large differences between the value end users obtain from their use of Wi-Fi access as well as the difficulties in billing them for that value would make both the formation of a bidding coalition and bids based on a high future stream of income difficult. In any event, the prior Wi-Fi rollouts in other bands have generated substantial economic value for citizens without a need for auctions, reflecting the fact that use of the technology does not require high levels of centralised capital allocation. The difficulty of generating bids that value the upper 6 GHz spectrum at its potential value to users for Wi-Fi means that, in a bidding competition between mobile and Wi-Fi, Wi-Fi would be disadvantaged as a bidder compared to mobile. The very decision to use an auction would thus, in itself, not be technologically neutral but would rather amount to an administrative decision favouring the preferred use of the spectrum. Due to the bidding challenges for Wi-Fi, the final allocation of a tender could well result in a lower societal value for the usage of the spectrum than from simple allocation as licence-exempt spectrum.

[1] Generally referred to as "unlicensed spectrum" in the US.
[2] See GSOA letter - https://gsoasatellite.com/news/2619/. Note that an auction could also only be held where it was certain that use of the spectrum involved did not give rise to interference with other services.
[3] GSMA Intelligence (2022) "The socioeconomic benefits of the 6GHz band", p.4.

2. Context

2.1. In November 2023, the World Radiocommunication Conference (WRC) of the International Telecommunications Union (ITU), a United Nations body, might take a decision that could adversely impact how member states in ITU Region 1 make available the upper 6 GHz band of spectrum to new communication services. Region 1 consists of Europe, including the UK, as well as Africa, the Commonwealth of Independent States and the Middle East (west of the Persian Gulf).

2.2. While countries are free to ignore the ITU recommendation, typically, they will follow it[4]. If the WRC-23 makes such a recommendation, it will be because the regional blocs of countries have supported the recommendation. Such recommendations have up until now meant that spectrum will be licensed and therefore preclude access to the band for licence-exempt use.

2.3. Currently, the four separate regional blocs in Region 1, organised by the European Conference of Postal and Telecommunications Administrations (CEPT), the African Telecommunications Union (ATU), the Arab Spectrum Management Group (ASMG) and the Regional Commonwealth in the Field of Communications (RCC) are forming their respective collective views.

2.4. While UK OFCOM is an influential voice in CEPT, the latter's position could be strongly influenced by the EU as a majority of CEPT members are EU member states and the latter are likely to vote as a bloc. It should be noted that the UK has recently taken the position to support "No Change (NOC)" for the U6 GHz at the WRC-23; meaning that this band should not be identified for IMT[5] by the ITU[6].

2.5. The EU Commission is expected to make a recommendation to the Council in February having received an opinion from an advisory body of EU member state spectrum authorities, the Radio Spectrum Policy Group (RSPG). Some European countries are leaning towards allowing mobile operators to use the upper 6 GHz band, others are concerned this means missing out on new applications and services and prefer it to be made available for licence-exempt use, such as Wi-Fi. As a compromise, the RSPG has recommended that the EU's position should be to "accept" a mobile identification for upper 6 GHz at WRC "while not advocating it or proactively supporting it"[7], thereby leaving the initiative at WRC with countries outside the EU.

2.6. The decision as to which additional uses, besides satellite and fixed link services, the upper 6 GHz will accommodate is controversial because a choice has to be made by countries whether to

[4] The regulatory regime to access spectrum, whether through licences or licence-exemption, is determined by the national administrations. The ITU and WRC proceedings deal with spectrum harmonisation and cross-border interference mitigation, including identifying spectrum bands for different technologies. One of the topics under discussion at WRC-23 is whether the 6 GHz band requires an IMT identification, meaning that the band can be used by the technology that delivers cellular mobile services. To the best knowledge of the author, all the bands which received an IMT identification to date have been licensed, often through auction processes. Therefore, if a band receives an IMT identifications, it will most likely be licensed by the countries.

[5] IMT stands for international mobile telecommunications.

[6] UK Ofcom Update on the upper 6 GHz band: our current position in preparation for WRC-23 (PDF, 372.8 KB)

[7] See RSPG opinion on WRC-23. The recommendations provided were also subject to some additional conditions.

license it to mobile operators or to open it to licence-exempt use, primarily by Wi-Fi enabled products.

2.7. Interference issues mean policymakers are faced with an either/or choice regarding the use of this band for technical reasons. Due to the lack of substitutability between the services (see section 4), they effectively face a choice in the short-term between favouring the increase of either current and future indoor broadband capacity delivered by Wi-Fi or creating an option for future capacity for mobile services[8]. One of the arguments brought forward by some players in the mobile industry is that if upper 6 GHz is licensed, then the governments can hold auctions[9]. This of course raises the prospect of a contribution to government receipts.

2.8. The Organisation for Economic Co-operation and Development (OECD) has recently provided the mobile industry with an additional supporting argument. In a recent paper, where it seeks to publish guidance to national spectrum managers on spectrum allocation, it argues that auctions are always the best way to allocate spectrum because they lead to the most economically efficient use of the spectrum[10]. Interestingly, the OECD paper also notes that a number of countries, have instead avoided auctions and allocated upper 6 GHz to licence-exempt use including Wi-Fi[11]. These countries see technology sectors as important contributors to future economic growth and include Saudi Arabia, South Korea and the United States[12]. The OECD paper does not examine whether countries opted not to adopt auctions of upper 6GHz because they considered that such an approach would give rise to inefficient economic outcomes.

2.9. Auctions can be an efficient way of allocating resources. However, auctions are not always the best way of allocating resources, as suggested by Borenstein (1988), noting in particular that new license holders may be able to capture only a small portion of the social surplus generated by the license, which can in turn affect their ability to bid. In this paper I set out why an auction in the specific circumstances of upper 6 GHz would not likely lead to the most efficient economic outcome and why countries would be ill-advised to follow any advice which suggests that an auction for U6 GHz should automatically be considered best policy.

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[8] An option for which it may be unnecessary to take the opportunity of reserving now given that when mobile providers actually need new bandwidth an alternative bandwidth will likely be useable.

[9] Huawei for example has held out the prospect and necessity of auctions: Telcos will require more spectrum resources to offer '5.5G': Huawei" (rcrwireless.com); and see also Huawei presentation to the Namibian communications regulator, slide 34: https://www.cran.na/yglilidy/2021/10/20211007-Huawei-presentation-for-CRAN.pdf. Cave and Webb (2015) note the auctions for mobile spectrum have been common in recent decades. Nonetheless, Cave (2002), while advocating auctions generally, recognizes that some spectrum uses were likely not suited to auctions.

[10] In its October 2022 paper, "Developments in Spectrum Management for Communication Services", the OECD writes "When the demand for spectrum exceeds the supply, as has been the case for mobile broadband applications, market assignment mechanisms, such as auctions, have become best practice in OECD countries. Well-designed auctions continue to be the gold standard in the OECD as they enable the licence to be assigned to the party that will make the most efficient use of it". P.4.

[11] Ibid, pp18-20 and 56-59.

[12] Saudi Arabia's intent, for example, set out in the statement Vision 2030, is for its economy to become a digital leader, Government of Saudi Arabia, "Vision 2030", p.44.The government reports its motivation for ensuring Wi-Fi access to the full 6Ghz band as "The Kingdom's proactive decision to dedicate the entire 6 GHz band to unlicensed technology comes after recognizing the economic benefit of using unlicensed wireless technology": https://www.trade.gov/market-intelligence/saudi-arabia-enables-6-ghz-band.

3. Auctions

3.1. The OECD states bluntly that auctions are effective for ensuring the most efficient use of allocated spectrum.[13] This would be true if it were the case that all bidders were in the same starting position and that the only thing that differentiated them was the long-term economic value of their respective products. In the hypothetical case where we have two otherwise similar bidders, the one that will make the higher returns because her product is more valued by society will be able to bid more.

3.2. Auctions for a spectrum are not however suitable under a range of conditions which vary from the simple case above. Auctions do not select for the technology which is most valuable for the economy as a whole, if it is feasible for a substantial number of users of this technology to avoid paying for the service. They will also be unsuitable for any technology where each potential bidder is small relative to their aggregated demand (despite their overall demand surpassing that for any rival technology). In the latter case, there would be coordination problems in putting together a joint bid. This will be particularly difficult where devices using the spectrum would have high variability in their costs, margins, and end-user values. Where aggregation is necessary to compete in the bidding process but where the bidders are actual or potential competitors, coordination would also be illegal under competition law.

3.3. Examples of government assets that have been distributed without auction include the provision by cities of land for hospitals or doctor practices, in order to increase supply of a good that might otherwise be undersupplied or to reduce the cost of a good that might otherwise be too expensive. Milgrom et al. (2011) suggest that allocating spectrum with dual possible uses of Wi-Fi or mobile by auction would be like asking park users to bid against developers for park land. The task would be even harder in the case of Wi-Fi users as compared to those in Milgrom's example because current Wi-Fi users will not be able to identify the future values that might come from innovation.

3.4. For spectrum itself, where Coase is commonly cited as an advocate of use of auctions, government has often allocated spectrum without conducting auctions. For example, to education and public broadcasting providers.[14] Coase himself said, with regard to how to delimit rights to spectrum, "[h]ow far this delimitation of rights should come about as a result of a strict regulation and how far as a result of transactions on the market is a question that can be answered only on the basis of practical experience"[15.] Wi-Fi too has benefited from an earlier round of allocation without auctions. This licence-exempt spectrum has not led to a tragedy of commons for Wi-Fi, which has developed means to mitigate interference. Moreover, expanding the use of Wi-Fi has not required large, centralised investment, which could otherwise be one reason to provide exclusive rights that yield "monopoly"[16]. Papers arguing in favour of other allocation mechanisms for some spectrum include Borenstein (1988) who discusses inefficiencies of auction allocation for both exclusive operating licenses and radio and broadcasting licenses, Milgrom et al. (2011) who discusses imperfections with auction allocation of spectrum and Lehr (2004) who argues that exclusive licenses are not superior to licence-exempt spectrum and not essential to promote

[13] See OECD (2022), p.4, even referring to well-designed auctions as the OECD "gold standard", and p.24.
[14] In fact, US spectrum is provided with an obligation to radio and TV broadcaster that even the private operators of spectrum must provide "public service".
[15] See Coase (1959), p.34.
[16] See Brake (2015), p 9.

investment. Milgrom, who won a Nobel prize for his work on auctions, and his co-authors argue against a universal presumption in favour of auctions for spectrum, focusing on factors like the innovation value that has been achieved with licence-exempt spectrum.

3.5. If the only bidders that are permitted to take part were those willing to offer a mobile service in upper 6 GHz then we as a society would be opting *overtly* to privilege future telecoms mobility over current and future indoor telecoms capacity. I explain in sections 4, 5, and 6 why I think that would not be good policy. However, the OECD paper could also be interpreted as suggesting auctions are also a good way of choosing between technologies. As regards upper 6 GHz, this is primarily a choice between mobile and Wi-Fi. If we were to use auctions as a way to decide between the two, we would be potentially *covertly* restricting this spectrum to the highest-bidding mobile provider(s).[17]

3.6. The reason why holding an auction which was open to bidders from either the mobile or Wi-Fi ecosystems would likely see mobile win, regardless of the overall economic merits, is because of key differences in the economic characteristics of the bidders.

3.6.1. There are three key characteristics of mobile operators. First, mobile operators are large multinational companies whose business cases typically begin with the financing of multi-billion-dollar (or equivalent currency) auction bids. They have an infrastructure for making bids. Second, they are given the possibility by governments to operate in monopolistic competition. This occurs in the following ways: mobile operators can make a reasonable assessment of their long-term profitability because they can control access to the spectrum used by their networks and thereby exclude non-billable customers; governments deliberately restrict the number of mobile operators to facilitate this same predictability regarding profitability; and, where forecasts are over-optimistic, mobile providers are allowed to adopt other forms of monopolistic behaviour to keep profits higher, for example sharing infrastructure with other members of the tight oligopoly or by postponing the meeting of licence requirements to supply less profitable areas.

3.6.2. Wi-Fi is instead a distributed product technology incorporated by myriads of competing manufacturers into potentially any electronically enabled product. Roll out of the service is decided by consumers purchasing enabled products, as operating in the band does not require a licence. Instead, products simply have to meet a general product standard to avoid interference. I consider who from the Wi-Fi ecosystem could perhaps take part in a bid to compete with mobile operators and why this is either infeasible or would require similar grants of monopoly to those enjoyed by mobile operators. The latter would constitute such bad public policy - due to the knock-on effects that spectrum monopoly would then have on much bigger end-user markets - that no sensible public authority would likely countenance offering it. The hypothetical bidders could be: chip companies; manufacturers of Wi-Fi enabled products; telecoms operators which provide connectivity through fibre; and end users. Their situations are considered one by one.

[17] Weiser and Hatfield (2008) critique the argument for universal replication of auctions across all uses based on its success in the cellular bands, stating "[The success of property rights in the cellular bands] rests on a particular set of circumstances that is unlikely to exist across the board." pp588-91.

3.6.2.1. Chip set companies

In theory, chip set companies are of the size and sophistication that they could hypothetically create the capacity for themselves to bid for spectrum licences. However, they could only bid higher than the mobile operators if they were given similar grants of exclusivity to those given to mobile operator. This would be necessary so that end users could not bypass the products licensed with the winning bidder's chips and still use Wi-Fi (or other licence-exempt technology using the spectrum). However, the consequence of such a grant would be that only the chips of the winning bidder could then be used to enable electronic products. This would likely lead to even greater concentration in the chips market, an outcome running entirely counter to public policy in many regions which is to encourage and/or finance the creation of new chips producers[18]. It would also mean that the winning chips producer(s) would decide which and how many end-user products were licensed to use the spectrum. Currently this is instead the result of end-user choice interacting with the supply from a very large universe of manufacturers. In other words, monopolisation in a relatively small market for spectrum rights would potentially have monopolization effects on the much bigger market for all Wi-Fi enabled products. This would have damaging effects for innovation at product level and in the processes and organisation of businesses generally.

In practice, multinational companies providing chips for products in licence-exempt markets, which already constitute an important part of world GDP, are unlikely to want to take on the transaction costs of creating a suite of spectrum bidding and then policing infrastructures for what will likely become a set of national markets comprising a minority of global GDP. Due to the fact that spectrum auction systems are national, the costs of building such an infrastructure are considerable. Reluctance would be even more likely given that preventing bypass of exclusivity would be complicated by the widespread availability of lower cost Wi-Fi enabled products in licence-exempt markets (see section 4).

3.6.2.2. Manufacturers of Wi-Fi enabled products

Aggregating the interests of manufacturers that are deploying chips in their products is infeasible as a matter of organisation. The difficulty of aggregation would arise from multiple sources: high variation in commercial value of each use, making agreement on how to share costs of a bid problematic; difficulties in handling relationship risk in a group; and, non-presence of future innovators who will create future products that could operate over the flexible use case. It would also be contrary to competition law, as the coalition would include actual or potential competitors. In any event, for it to be economically rational for participants in a bidding coalition to participate, or for any individual producer, they would have to be able to replicate the licensed exclusivity of the mobile providers. It is inconceivable that giving exclusivity for Wi-Fi enabled products to a particular manufacturer or limited set of manufacturers would

[18] See for example, the European Commission's explanation as to why the EU needs to adopt a Chips Act in order to encourage chips manufacturing in Europe in order to achieve strategic autonomy: https://ec.europa.eu/commission/commissioners/2019-2024/breton/blog/how-european-chips-act-will-put-europe-back-tech-race_en.

be good public policy. Monopolisation in a relatively small market for spectrum rights would potentially have monopolization effects on the much bigger market for all Wi-Fi enabled products. Such a development would be particularly unacceptable as with the development of the Internet of Things (IoT), this is increasingly becoming all manufactured products.

3.6.2.3. Telecoms operators offer indoor broadband services

Allowing fibre-based telecom operators to bid for Wi-Fi licences would potentially involve large companies that could develop the bidding infrastructure. However, once again the companies would require exclusivity which would reduce competition in the telecoms market as Wi-Fi is the primary mechanism by which end-users access broadband indoors[19]. It would also mean that telecoms companies were deciding which end-user products were licensed to use the spectrum. As described above, we would be moving from a model where end-users can decide and can experiment with a product from any manufacturer to a far more centralised decision-making process. The cost of access to broadband, including fibre would also rise, at a minimum to cover the price bid to win the auction (such price rises would also occur in the product markets above too, should they be the winners).

3.6.2.4. End users

The other hypothetical alternative would be crowdfunding the bid at the level of end users or making users pay based on the value of their usage. Neither of these would be serious propositions, due to the limited capacity of crowdfunding and to the difficulty of excluding users on Wi-Fi who do not pay for their spectrum use.

3.7. The highly probably consequence of the points above is that having an auction ostensibly designed to select between different technologies for upper 6 GHz would in practice be a decision to decide which mobile operators would use the spectrum in a particular geography.

3.8. For all the same reasons described in sections 3.6.2.1. to 3.6.2.4. above, an auction limited solely to participants in the Wi-Fi ecosystem would also be a very poor way of achieving efficient economic outcomes. It would also be unnecessary as Wi-Fi has developed standards which allows a wide ecosystem of providers and users to thrive.

3.9. Arguments have been made that the relative revenues potentially realised on the U6 GHz band from 5G would be greater than those on Wi-Fi and that this can be used as a proxy for the relative social value of the two systems[20]. But such comparisons (based on prior operator willingness to pay) do not directly indicate consumer benefits. Evidently, consumers prefer less expensive spectrum access rather than more expensive access, however in the case of mobile their options are limited due to highly concentrated markets and the need to meet the high systems costs for portable data access. But some consumers able to pay more, may do so for an imperfect substitute if their alternatives are constrained or degraded. The assumption that spectrum is most valuable when revenues are maximised is particularly problematic when revenues would be maximised on a market with substantial concentration, like mobile, due to supply constraints on the market for a cheaper technology.

[19] Cloud providers would be in a similar position.
[20] E.g., Layton and Witkowski (2021).

4. Lack of substitutability between mobile and Wi-Fi

4.1. Competition between mobile and Wi-Fi is limited only to marginal cases, with Wi-Fi usually considered a more effective means for end-users to access large quantities of data.

4.2. When indoors, accessing data over a mobile plan is more expensive for end users than using a broadband Wi-Fi connection. Without performing a detailed analysis of costs and benefits[21], several points are worth considering with respect to the relative economic benefits of Wi-Fi compared to mobile use of spectrum. The first is that internet traffic is likely to grow considerably in the near future, placing stress on the Wi-Fi/mobile systems to deliver. To the extent demand is met in fixed locations, the relative cost of traffic sent over the fibre to Wi-Fi or mobile 5G systems differs substantially. An informal comparison of end-user costs, based on consumed traffic in the UK, can suggest data costs of £6.61 per GB and £0.08 on fibre[22]. To the extent such figures are generalised, one can conclude that it is in the consumer interest, and overall interest of efficient data carriage, to push traffic towards fixed network provision where feasible.

4.3. Multiple studies have found that a combination of fibre and Wi-Fi connectivity uses far less energy than mobile connections, particularly indoors[23]. To penetrate building walls, 5G services need to consume high levels of power. As a result, connecting an indoor device to an outdoor base station will use a disproportionate amount of energy, while also resulting in shorter recharge cycles, increased battery wear, and additional electronic waste.

4.4. In recognising this relative efficiency of Wi-Fi indoors, mobile operators themselves offer Wi-Fi routers to customers for accessing services indoors. Mobile providers primarily serve outdoor markets giving users the ability to roam (i.e., they offer mobility) whereas Wi-Fi enabled products provide a capacity service indoors (a definition that includes large spaces such as stadiums, factories, universities, airports, shopping malls, etc). In the circumstances where players in the Wi-Fi ecosystem had to capture the full use value of Wi-Fi in order to mount a competitive bid in an auction, the design of Wi-Fi routers would have to be reconfigured to require that mobile users pay to access faster indoor services.

4.5. There are also significant capacity differences, affecting the quality of use. Mobile quality can deteriorate significantly inside buildings. At the very best outdoors, on a 5G network, a handset might achieve a download speed of 200 Mbits[24] whereas fibre accessed over Wi-Fi is available for

[21] For an example of such calculations, see Carew et al. (2021), GSMA (2022) and Katz et al. (2021).

[22] These numbers are obtained by dividing the average monthly user mobile consumption by the average prices of the cheapest unlimited 5G offers by the leading UK MNOs; this yielded £6.61 per GB per month. Taking the average monthly fixed broadband consumption and dividing it by the average broadband packages which have speeds comparable to the average peak 5G performance among the UK mobile operators yields a per GB result of £0.08.

[23] WiK Consult and Ramboll (2021), p.29, cite findings that a FTTH connection emits 2 grams of greenhouse gas emissions when streaming a video for one hour, compared with 5 grams for a 5G network, 13 grams for a 4G network and 90 grams for a 3G network. More recently, the French regulator ARCEP in a 2022 report, "Findings of the ADEME – ARCEP joint task force to measure the digital environmental footprint in France", says that "Per GB of traffic, mobile networks have close to three times the footprint of fixed networks for all the environmental indicators studied.

24 https://www.ispreview.co.uk/index.php/2022/09/opensignal-name-best-4g-and-5g-uk-mobile-networks-for-q3-2022.html

47% of the UK population and rising and speeds of 1GB are available[25]. Future application demands around immersive experience such as VR/AR, wearables, telehealth, industrial Internet of Things (IoT), robotics/automation and 3D video require extensive computational resources within the premises and speeds that are 100s or 1000s of times faster than 5G.

4.6. Mobile operators view building a mobile network that rivalled the capacity delivery of Wi-Fi as prohibitively expensive even where it was not made impossible by planning requirements (it would effectively require a mobile network with roughly the same mast density as there are Wi-Fi routers in individual households and businesses)[26].

4.7. Wi-Fi infrastructure is being built out at the cost of individual households and businesses, in a way that inherently reflects the value to the citizen of the activity, sometimes low and sometimes high. This is a distributed model for generating value. When the value of a new activity is greater than the cost of material and inputs, the buildout occurs. The spectrum will thus be used in many different ways for Wi-Fi, allowing maximisation of value from current products and future innovations, and maintaining openness to providers of innovation that are not yet in the market and not owned by existing Wi-Fi players. The Wi-Fi use can also begin immediately (noting that Wi-Fi 6E operating across the whole 6 GHz band 5925-7125 GHz is shipping today) while the flow of potential benefits from alternative uses of U6 GHz by mobile would not materialise for at least 6-8 years[27].

4.8. Mobile infrastructure is built out under a command-and-control model that is highly centralised. This reduces the likelihood of innovations being subject to a market test, by creating a central authority that determines whether rollout of end-user products can occur. Mobile use is likely further to result in a much slower roll out of usage of the spectrum.

5. Which technology currently needs access to U6 GHz?

5.1. Wi-Fi needs access to more spectrum for current and imminent generations of Wi-Fi technology. At this point the available bandwidth is not sufficient to avoid interference and to cope with capacity-hungry applications in congested environments. Wi-Fi 6 and 6e technologies are already on the market and Wi-Fi 7 products will become available during 2024.

5.2. Mobile does not need access to upper 6 GHz at this point in time[28]. One estimate is that at peak demand in the busiest mobile cells, mobile networks currently operate at less than 8% of their 5G

[25] OFCOM (2021) "Connected Nation", p.4.

[26] In its comment to Ofcom's Discussion paper, "Meeting future demand for mobile data", Vodafone UK states "scenarios of mass network densification are detached from commercial reality because current industry profitability cannot support the suggested level of investment" (p 4). Commenting on the same discussion paper, Three states "Even if small cell deployments were economic, Ofcom's assumption that we could deploy many thousands of small cells by 2030 is not realistic, in our experience." (p.15).

[27] Even assuming that the outcome from the WRC will be the recommendation that Upper 6 GHz can be used by mobile operators, it would likely take countries roughly two years to decide whether and how mobile operators would share the band with incumbent users. It would likely take a further two years for auctions to take place and licences to be issued. After this, operators could start to deploy equipment, but this would depend on a range of factors including whether their existing spectrum had been fully used and whether there were handsets and other equipment available for the new spectrum. 6-8 years is a reasonable minimum estimate for the time that would lapse before mobile operators might start to use the band.

[28] https://on5g.es/en/sobre-on5g/

capacity[29]. Furthermore, growth rates of mobile data are below the lower bound of previous predictions[30]; the latest report by Tefficient[31] documents how data growth rates have been slowing and are now in the region of 15-20% a year across most countries. If mobile operators were allocated U6 GHz, it seems possible they would only use it to relieve congestion for existing mobility services in limited geographies for the next few years rather than offer new services. As a consequence, congestion might be relieved in some metropolitan cells for outdoor use whereas in an licence-exempt scenario, any end-user, whether an individual or a university, a hospital or a factory in any location, including remote ones, will have the option of deploying advanced services such augmented reality (AR) or virtual reality (VR), or e-healthcare.

5.3. The use of data over fixed networks substantially outstrips mobile. Every year, Germany's Bundesnetzagentur (BNetzA) publishes both the total volume of data delivered by fixed networks and by mobile networks. The data reported by BNetzA indicates that over 95% of data traffic occurs over the fixed network and less than 5% over mobile[32]. Additionally, if we look at the evolution of the relative volume of mobile and fixed data traffic in 2012-2020, these percentages have not moved significantly. Other countries also collect this type of information. In the UK, Ofcom's Communication Market Reports show similar volume splits, whereby the percentage of data over fixed networks exceeds 98% of the total[33]. Italy[34], Portugal[35] and Romania[36] also publish similar data, with mobile networks that carry small percentages of the overall data traffic.

5.4. A mobile standard which could be used in U6 GHz has been finalised[37] but mobile products which could use U6 GHz do not currently exist. Regulators that have opened the full 6 GHz band for licence-exempt use are also looking at mobile traffic use trends to understand whether, when and how more spectrum (if required) should be found[38]. It is likely bandwidth in higher ranges will be found in the timeframe where mobile would actually need it for new higher bandwidth services rather than as a way of relieving congestion in a small number of sites for current mobile services.

[29] Analysis based on the 82 5G networks considered in EU27 by Rewheel research's study "Mobile data usage in 2021 and 4G & 5G operator capacity potential", published in March 2022. Source: https://research.rewheel.fi/downloads/Mobile_data_usage_2021_capacity_potential_170_operators_50_countries_PUBLIC_VERSION.pdf

[30] In the discussion paper Meeting the future demand for mobile data, Ofcom presented three scenarios, Low growth (25%), Medium growth (40%), and High growth (55%). New data show that even the "Low growth" scenario is optimistic.

[31] Source: https://tefficient.com/further-slowdown-in-data-usage-growth-causes-positive-arpu-development-to-soften/

[32] https://www.bundesnetzagentur.de/SharedDocs/Mediathek/Berichte/2021/TTB2020.pdf

[33] https://www.ofcom.org.uk/research-and-data/multi-sector-research/cmr

[34] https://www.agcom.it/documents/10179/5667564/Allegato+22-4-2022+1650621446557/687aee0e-72e7-4322-9f57-7e9e26f5c19b?version=1.0

[35] https://www.anacom.pt/streaming/Sector_das_Comunicacoes2021_12maio2022.pdf?contentId=1721562&field=ATTACHED_FILE

[36] https://statistica.ancom.ro/sscpds/public/files/244_ro

[37] https://www.mobileworldlive.com/huawei-updates/3gpp-officially-completed-the-specification-of-the-upper-6ghz-licensed-band-for-5g/

[38] https://www.fcc.gov/document/fcc-examine-127-ghz-band-next-gen-wireless

6. Large scale economic effects

6.1. Likely low auction valuations would limit upfront government revenues

The value of a single asset in an auction is broadly based on the long-run value to its second highest user, which would presumably be another mobile telecom company. Given that 5G is so little extended for the moment and business cases for mobile use of U6 GHz are yet to be developed, the present value of probable expected returns will be relatively low. Proceeding with an auction in such an environment, would likely generate low auction proceeds for governments.

6.2. The consequence of an auction is likely to depress long term tax take for Treasuries

As discussed in section 3 above, adopting an auction process would likely ensure the selection of mobile as the winner. As a likely lower value generating activity than Wi-Fi for the wider economy[39], this could depress the quantum of taxation which the government receives from ongoing hardware and affiliated services related to Wi-Fi. The Wi-Fi ecosystem is already selling the equipment that can take advantage of U6 GHz. If mobile adopts the 6G technology that could take advantage of U6 GHz, this likely to be a decade away. Businesses and consumers could be re-equipping themselves now with enhanced Wi-Fi and generating increased current economic activity.

6.3. Economies of scale will be lost for users

Countries representing 31% of world GDP (including USA, Brazil, Canada, South Korea, and Saudi Arabia) have already decided not to allocate the 6 GHz band to mobile and to ensure Wi-Fi has licence-exempt access to the full band[40].

If other countries pursue a different path, they will face the cost of losing the economies of scale which would otherwise have been available through global common practice[41]. Current Wi-Fi 6E equipment is already being shipped with support for the whole 6 GHz band and Wi-Fi 7 products will follow during 2024. This means that the cost of designing and providing this support for the band will be paid by customers regardless of whether a country will open or not the band for unlicensed use. In other words, not opening the band will cause consumers to partially pay for capabilities they are not using, hence indirectly subsidising consumers in countries with access to the whole band.

6.4. Other parts of the world, including the EU, have allocated lower 6 GHz to Wi-Fi but await the conclusion of the ITU process in order to decide how to allocate the U6 GHz part of the band.

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[39] Katz et al. (2021).

[40] The OECD's comment on the allocation of Upper 6Ghz for unlicensed use is that this approach has been adopted by 13% of a sample of countries they selected (p.20). However, if spectrum managers are considering the scale gains or losses of different approaches, the number of countries (in a sample) that have opted one way or another is a poor indicator for the size of likely effects. Scale gains are determined by the aggregated size of the accessible markets, not the number of markets.

[41] As the OECD note: ""One of the main benefits of global harmonisation at present is that it provides certainty to the market on what services may be developed and offered in an allocated band, and what equipment could be manufactured, potentially creating economies of scale. Global harmonisation allows for the emergence of ecosystems conducive to the expansion of services, where the alternative could be fragmented national approaches to allocation"[41] (op. cit.p.17)

7. Conclusion

While auctions are often a good way of allocating scare resources to their most efficient use, this is not always the case. There are circumstances in which auctions do not give rise to the best societal outcomes. The nature of supply and demand for Wi-Fi, including for the use of the whole 6 GHz band (5925-7125 GHz) band, makes it a case that reasonably falls into the latter category.

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