Overcoming SEP hurdles to stimulate the UK IoT

An economic analysis

Prepared for

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LIST OF ABBREVIATIONS

AIPLA	American Intellectual Property Law Association
AMI	Advanced Metering Infrastructure
AMR	Automated Meter Reading
ARB	Aggregate Royalty Burden
CAGR	Compound annual growth rate
CAN	Controller Area Network
ECJ	European Court of Justice
ETSI	European Telecommunications Standards Institute
FRAND	Fair, Reasonable and Non-discriminatory
FTC	Federal Trade Commission
GSM	Global System for Mobile Communications
IEEE	Institute of Electrical and Electronics Engineers
IoT	Internet of Things
IP	Intellectual Property
LoRa	Long Range Wide Area
LTE	Long Term Evolution
LTE-M	Long Term Evolution Machine Type Communication
NB-IoT	Narrowband IoT
OBD-II	On-Board Diagnostic II
OEM	Original Equipment Manufacturer
Ofgem	Office of Gas and Electricity Markets
R&D	Research and Development
SDO	Standards Developing Organization
SEP	Standard Essential Patent
SME	Small and Medium-sized Enterprises
SMETS	Smart Metering Equipment Technical Specifications
UMTS	Universal Mobile Telecommunications System
WI-FI	Wireless Fidelity

EXECUTIVE SUMMARY

The potential of the Internet of Things (IoT) to significantly contribute to economic growth and innovation in the UK is immense. As the interconnected network of devices and sensors continues to expand, it has the power to revolutionize industries, enhance productivity, and create new business opportunities. By leveraging IoT technologies, UK businesses can optimize operations, automate processes, and improve efficiency, leading to cost savings and increased competitiveness.

Cellular and Wi-Fi are the main royalty bearing connectivity standards powering the IoT, with the former making up the great majority of Standard Essential Patent (SEP) licensing disputes in recent years, pointing towards unaddressed frictions in the cellular SEP licensing landscape. Cellular SEP holders have recently broadened their licensing endeavours beyond mobile phones and consumer electronics, venturing into the domain of connected cars. Now, these holders are actively pursuing opportunities to monetize other verticals of the IoT. The products and services of a large and growing number of UK companies, including small and medium-sized enterprise (SME) start-ups, involve cellular connectivity; but these businesses have not been able to license the standardised cellular technologies. This carries the risk that SEP licensing friction will slow the growth of the UK IoT.

To support the UK Government in creating a policy environment that facilitates and encourages UK investment and innovation, we have been asked by the Fair Standards Alliance to analyse to what extent the current SEP licensing practices are efficient and appropriate for the Internet of Things (IoT) and to identify scope for improving the SEP licensing framework in the UK. To this end, we analysed in more detail the SEP licensing risk exposure of the UK smart energy meter sector, the UK smart water meter sector, and the UK telematics sector. Our main findings are as follows:

- **The IoT has become an important part of the UK economy and has an impressive growth potential (Section 2).** The global market size of the IoT sector is currently estimated to be around £204bn (2022), and industry forecasts indicate that it might exceed £500bn by 2030. The UK market size in 2022 is estimated at £27bn and is expected to grow with a compound annual growth rate (“CAGR”) of around 11.8% until 2026 – with accelerating momentum.
- **Interoperability of IoT devices within and across applications is ensured by a wide range of standardised technologies (Section 3).** In particular, the connectivity of devices, the defining feature of the IoT, is enabled by the use of the two main royalty bearing connectivity standards, cellular and Wi-Fi, as well as other standards such as Bluetooth, Thread, Matter, and Zigbee, which are licensed on a royalty-free basis. New IoT applications have led to a significant increase in the use of cellular standards.
- **Unaddressed SEP licensing issues in the cellular space will be exacerbated in the IoT (Section 4).**
  - If SEP licensing for the IoT is done at the end device level, the number of licensing transactions will sharply increase (Section 4.1). Cellular SEPs are very fragmented, with hundreds of SEP holders. Even if some of the complexity can be reduced through pool licensing, potential licensees will have to negotiate with multiple potential licensors and pools, including Non-Practicing-Entities (NPEs) that have brought SEP litigations in the UK in the past.

While IoT chipsets are globally supplied by 8 main players, the IoT has led to a sharp increase in end device manufacturers. We estimate that there are at least 2,800 IoT device manufacturers which use cellular SEPs, more than 200 of which are based in the UK. The UK appears to be the second-largest host country for cellular IoT device manufacturers after the U.S.

- Efforts by SEP holders to license at the end device level will result in enormous transaction costs for negotiating licences for the IoT (Section 4.2). We simulate transaction costs (including costs for external legal and technical advice as well as for potential litigation) from end device and component level licensing for the IoT. Considering a range of litigation costs and assuming that merely 5% of licensing negotiations end up in litigation, the estimated transaction cost burden on a single device manufacturer in the IoT sector amounts to an average of approximately £1.5m - £4.8m depending on the size of the litigation costs. However, a recent study suggests that the share of SEP licensing negotiations that result in litigation would be much higher. Assuming that one in five negotiations ends up in litigation, estimated transaction costs for licensing cellular standards increase to as much as £3m - £16m for an IoT OEM on average, for a single generation of cellular standards. The estimated transaction cost levels would certainly constitute a significant burden - if not an existential threat - to many start-ups and SMEs in the IoT sector.

  Transaction costs associated with end device level will result in estimated worldwide industry transaction cost between £4.3bn - £13.5bn (litigation probability of 5% per negotiation) and around £8.5bn - £45.4bn (litigation probability of 20% per negotiation). This enormous amount is driven by the large number of downstream IoT device manufacturers who, even under conservative assumptions, can be expected to be in the thousands. Transaction costs borne by UK companies will be between £315m - £998m (litigation probability of 5%) and £630m - £3.4bn (litigation probability of 20%).

  We estimate that more than 99% of the estimated licensing transaction cost in the IoT sector could be saved if licensing was done at the component level. Even if the entire transaction cost is passed through and would ultimately be shared among end device manufacturers, the cost per OEM when licensing at the component level would be only around 1% of the transaction cost borne under device level licensing. Assuming that around 5% of licensing negotiations end up being litigated, we estimate the average transaction cost per UK downstream OEM to be around £15k - £32k, an amount that could still be borne by most start-ups and SMEs.

  - Licensing at the end device level will lead to more unbalanced negotiations and thus a higher likelihood that UK companies are coerced into licences at non-FRAND rates (Section 4.3). While smaller companies may try to minimise litigation costs by accepting onerous licensing terms to avoid litigation, such a strategy can result in inefficiently high royalty rates, undermine manufacturers' competitiveness. IoT end device manufacturers may lack SEP licensing experience, expertise, and resources to properly evaluate and challenge the demands of SEP holders. In addition, sunk investments per licensed unit and the potential for hold-up tend to be higher at the end device level. Recent evidence of discriminatory SEP royalties highlights the risk that SEP royalties can contribute to an uneven playing field. Margins in many IoT verticals are thin, exacerbating the risk of distortions.
  - Disputes over the licensing of cellular SEPs in the automotive industry can serve as a cautionary tale of how an entire industry can be disrupted quickly once SEP holders start to enforce their SEPs (Section 4.4). After the formation of the Avanci "Automotive" pool, a litigation wave coerced car manufacturers to license SEPs at the end device level within a short timeframe. The formation of the Avanci "Aftermarket" pool in the first half of 2023 suggests that history may repeat itself - this time targeting UK companies active in the vehicle telematics space.

- **Turning to UK smart energy meters, the UK government has decided to rely on cellular connectivity for most of the UK premises, implying substantial SEP licensing risks (Section 5).** The cellular connectivity is implemented through cellular communication hubs that sit on the electricity smart meters. We estimate that the number of cellular communication hubs will increase to 23.7m devices by 2028. This requires 3.2m annual installations to account for all expected new installations as well as replacement of existing devices. SEP holders that refuse to license at the component level could target not only manufacturers of communication hubs, but also the Data Communication Company (DCC) that owns and operates the cellular communication hubs. Irrespective of whether the communications hub manufacturers or DCC will be targeted, licensing negotiation and potential litigation costs will be much higher than under component level licensing. Without intervention, SEP holders will enjoy leverage from hold-up which entails the risk that high, potentially non-FRAND royalty rates are extracted.

- **The deployment of smart water meters is projected to increase rapidly in the coming years (Section 6).** The smart water meter industry is still in its early stages and a variety of proprietary and standardised communications technologies are today used for water deployments. NB-IoT in particular is now emerging as real contender within the European water industry and can play a central role in achieving UK targets to increase the number of metered premises. In 2021, telecommunications provider Vodafone UK announced the establishment of a new IoT management platform for the UK water industry with connectivity to 98% of the entire UK geography. This platform will improve the infrastructure choice for water companies and will allow them to integrate a wide range of devices. Similarly, British Telecoms started the rollout of a nationwide IoT network in 2023. They will offer a range of communication technologies such as NB-IoT, LTE-M, and LTE-Cat-1. SEP licensing issues related to cellular communication technologies could potentially hinder its development and result in suboptimal technology adoption. Addressing these frictions is critical to facilitate a smooth and effective transition to smart water metering.
- **The UK transport telematics industry has established itself as an innovation hub, with numerous UK companies currently thriving in this space (Section 7).** Unit sales in the industry are already large today and are expected to increase significantly in the coming years. Using a very conservative methodology, we estimate that UK companies provided approximately 49m active connections by 2021, which is expected to increase to more than 86m in 2030. Annual unit sales are projected to increase from 7.4m units in 2021 to 9.8m units in 2030. We identify a high risk for SEP licensing issues in the UK telematics sector. First, Avanci's recent "Aftermarket" pool is specifically targeting transport & logistics devices and, given Avanci's licensing behaviour in the automotive industry, will likely target manufacturers at the end device level. Second, we see a high risk of litigation in the UK telematics sector as it can be expected that the Avanci Aftermarket pool members will adopt a similarly aggressive litigation strategy as with its Vehicle 4G pool. Third, the average estimated transaction cost from end device level licensing accruing to a UK company of more than £500k per cellular standard poses a serious threat for the commercial viability of some start-ups and SMEs in this space. Fourth, based on the headline royalty rates requested by the Avanci Aftermarket pool, we estimate that the aggregate royalty burden may be as high as 21% of the average telematics device price – clearly exceeding FRAND benchmarks for cellular standards as determined by courts in the past for mobile phones.
- **Appropriate measures to amend the SEP licensing framework will alleviate licensing frictions and facilitate SEP licensing in the UK IoT sector (Section 8).** First, it is of paramount importance that availability of injunctions based on SEPs is strictly limited. The risk of injunctions against users of standards leads to hold-up, excessive royalty rates, and ultimately to reduced investment incentives. Second, component level licensing should be promoted to reduce the transaction cost burden on UK innovators and to further reduce the risk of patent hold-up. Finally, appropriate measures should foster transparency in licensing negotiations, especially in relation to essentiality assessments and existing SEP licences.

1. INTRODUCTION

1. The UK is at the forefront of developing and deploying IoT solutions, driven by deployment strategies and innovation hubs clustered around specific IoT verticals. Cellular standards have widely emerged as a critical technology for enabling long-range communication across IoT device categories.[1]

2. Prior to the emergence of the IoT, cellular standards were predominantly used in the mobile phone industry. Licensing disputes related to cellular technologies have historically accounted a large share of SEP licensing litigation, indicating significant licensing frictions. The advent of the IoT has led to a material increase in the number and heterogeneity of firms that use cellular SEPs. Disputes over the licensing of cellular SEPs in the automotive industry can serve as a cautionary tale of how an entire industry can be disrupted within a short time once SEP holders start to enforce their SEPs. The formation of the Avanci "Aftermarket" pool in the first half of 2023 may mark the start of a new wave of SEP licensing disputes, this time targeting companies active in the vehicle telematics space, many of which are based in the UK. Similarly, Sisvel launched its cellular IoT pool in November 2022 to license smart meters, asset trackers and NB-IoT devices more generally. This report considers whether the current SEP licensing framework is appropriate to support a thriving UK IoT sector and highlights lingering licensing frictions which may hinder the future development of the sector. A key aspect to consider is the fundamentally different licensing environment in which the IoT finds itself compared to the mobile phone industry, and how this can exacerbate existing SEP licensing issues.

3. During the developmental phase of early cellular standards, such as 1G, 2G, and 3G, the mobile phone industry was characterized by the presence of a small number of large, vertically integrated companies such as Ericsson, Nokia, Alcatel, and Motorola. During this time, cellular SEPs were often cross-licensed between these manufacturers or licensed at the component level,[2] and SEP holders were less likely to view SEP licensing as a source of revenue.

4. The emergence of smartphones in the 2000s led to the entry of new players, including Apple and Samsung, while the market position of several traditional handset manufacturers declined. Following the disruptions in the mobile phone market, established companies such as Nokia and Ericsson, which had experienced a decline in revenue from device sales but retained substantial SEP portfolios, began to adopt a strategy of licensing their (cellular) SEPs to other device manufacturers, i.e. at the device level and basing their royalty

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[1] While IoT devices use various connectivity standards (including cellular, Wi-Fi, Bluetooth), our assessment focuses on the cellular standard as one of the two main royalty-bearing connectivity standards and the main source of litigation (see also Section 3).

[2] Ericsson was one of a number of companies that caused the European Commission to open an investigation in 2007 regarding whether Qualcomm was harming competition by breaching its FRAND commitments and failing to license competing baseband chip suppliers. Nokia, another company currently supporting end product licensing, was part of that group and advocated to the European Commission that Qualcomm's termination of a licence with baseband chip supplier Texas Instruments "would breach Qualcomm's duty to license on FRAND terms, after having induced SSOs to base the CDMA and UMTS/W-CDMA standards on Qualcomm's technology. See https://www.ipwatchdog.com/2021/05/11/ssppu-appropriate-royalty-base-frand-royalties-cellular-seps/id=133403/ (accessed 11.05.2022).

demands on the average sales price of the devices.[3] The practice of licensing cellular SEPs at the end device level has sparked controversy and triggered intense debates among policy makers, SEP holders, downstream innovators, and academics.[4] Critics of the current framework have been arguing that it encourages hold-up strategies by SEP holders and leads to significantly higher transaction costs than alternative frameworks where SEPs are licensed at the component level.

5. The emergence of the IoT with a more fragmented implementer landscape will exacerbate the risk of patent hold-up under the current framework. In addition, end-device licensing in the IoT will likely lead to even more disproportionate transaction costs due to the significantly larger number of potential licensees in the IoT landscape.

6. The focus of this paper is first to assess licensing frictions looming on the horizon for the UK IoT sector. To this end, we examine the risk for SEP licensing issues in three key UK IoT sectors which are of particular importance for the UK economy: smart energy metering, smart water metering, and transport and logistics telematics.

2. THE IOT IN THE UK

2.1. Value of the UK IoT market

7. The disruptive potential of IoT most visibly manifests itself in the estimates and forecasts of the market value. Transforma Insights estimates the global IoT market size in 2022 at around £204bn.[5] Of this total market size around two thirds, or £133bn, relates to industrial applications (as opposed to consumer electronics). The IoT market is expected to grow each year by 14% on average up until 2026 with a market value of £345bn. This market value is predicted to exceed £500bn by 2030.

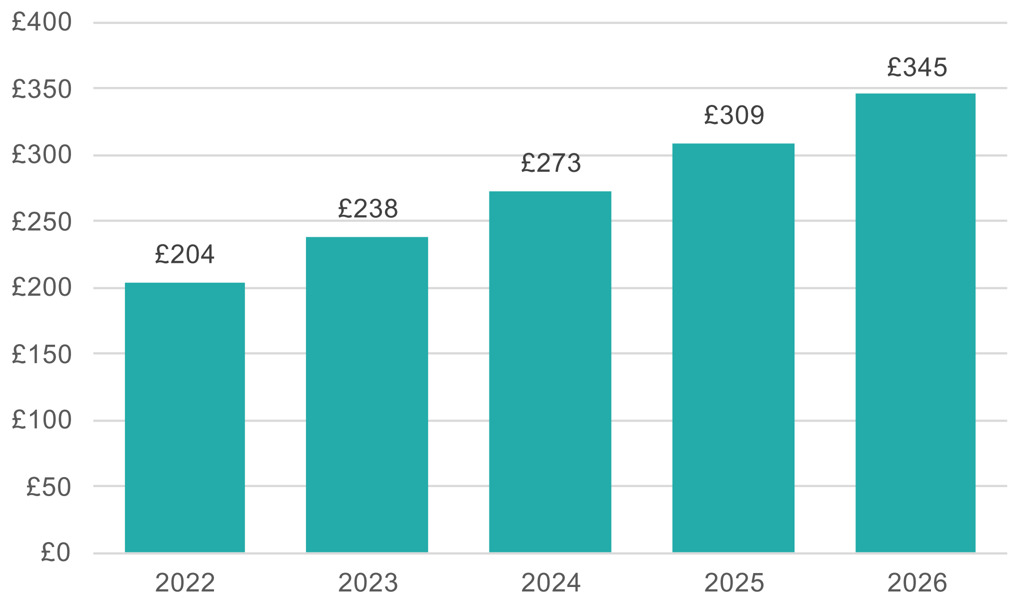
3 Nokia and Ericsson's decision to increasingly license their SEPs at the device level is commonly regarded as an attempt to increase their licensing revenues. For example, a Qualcomm executive explained during the court proceedings in *FTC v Qualcomm*: *"[S]o they also – following our lead I might say – you know, decided hey, we can license these patents and make money by doing and we can make more money licensing this than licensing the chip. So like they licensed the cell phone, not the chip*." FTC, 411 F. Supp. 3d at 755 (quoting CX-6786-R at 42:17-21). The Court was indeed convinced that Qualcomm and other SEP holders like Nokia and Ericsson refuse to license their SEPs to component suppliers as licensing to device manufacturers is expected to be more profitable (*Fed. Trade Comm'n v. Qualcomm Inc.*, Case No. 17-CV-00220-LHK (N.D. Cal.), Findings of Fact and Conclusions of Law, p. 130).

In fact, Ericsson's Director of Technology Licensing admitted: "One big advantage with this [device level licensing] strategy is also that it is likely that the royalty income will be higher since we calculate the royalty on a more expensive product." (http://www.fosspatents.com/2014/01/ericsson-explained-publicly-why-its.html, accessed 11.05.2022).

4 Geradin and Katsifis (2021).

5 Figures in the report have been transposed from USD to GBP using the 2022 annual average exchange rate by the Bank of England where applicable, available at https://www.bankofengland.co.uk/boeapps/database/fromshowcolumns.asp?Travel=NIxRSxSUx&FromSeries=1&ToSeries=50&DAT=RNG&FD=1&FM=Jan&FY=1963&TD=21&TM=Feb&TY=2022&FNY=&CSVF=TT&html.x=170&html.y=46&C=DME&Filter=N (accessed 30.07.2023).

Figure 1: Global IoT market value forecasts 2020-2030 (£bn)



Source: Global IoT revenue. Transforma Insights (2023). Available at https://www.statista.com/statistics/1194709/iot-revenue-worldwide/ (accessed 29.07.2023). Notes: Revenues are forecasted for the 2023-2030 period. Transforma Insight has substantially downward adjusted its revenue figures compared to a previous release of the data in 2021. Covers all industry applications and consumer electronics. Consumer electronics makes up for around 35% of total IoT markets.

8. The UK IoT market size in 2022 was estimated at around £27bn,[6] placing the UK IoT at around 12% of the global market. It was ranked as the seventh largest IoT market worldwide in 2021.[7] The total UK market size is expected to grow with a compound annual growth rate of around 11.8% until 2026 – with accelerating momentum.[8] The most important applications for IoT devices in the UK in 2021 are industrial (28% market share), retail (20%), and healthcare (18%).[9]

6 TechNavio, 2021. IoT Market in UK: Key Drivers and Segmentation.

7 UNCTAD (2019). p 28.

8 TechNavio, 2021, *Ibid*. Year on year growth rates are expected to increase from 10.86% in 2022 to 12.74% in 2026.

9 TechNavio, 2021, *Ibid*.

Figure 2: UK IoT market value forecasts 2021-2026 (£bn)

Source: TechNavio (2021). "IoT Market in UK by Technology and End-user – Forecast and Analysis 2022-2026". Available at https://www.technavio.com/report/iot-market-industry-in-uk-analysis (accessed 29.07.2023).

2.2. IoT applications

9. The IoT is widely expected to disrupt the way we perceive and define telecommunication, computing and the internet in general in the coming years.[10] In simple terms, the IoT describes connected objects, be it in a business/industry context or a private context at home, that create a communication network replacing the need for human-to-human or human-to-machine interaction. Typically, these are information and communication technology (ICT) devices that are embedded with technologies (sensors, software, etc.) which enable them to connect and exchange data with other devices and systems over the internet and other types of connections. Applications of these devices range from industrial applications such as smart manufacturing and smart grid, to consumer-oriented applications such as smart health and wearables. Figure 3 below presents an illustration.

Figure 3: Internet of Things – Applications

Source: CRA illustration based on IERC (http://www.internet-of-things-research.eu/, accessed 11.05.2022).

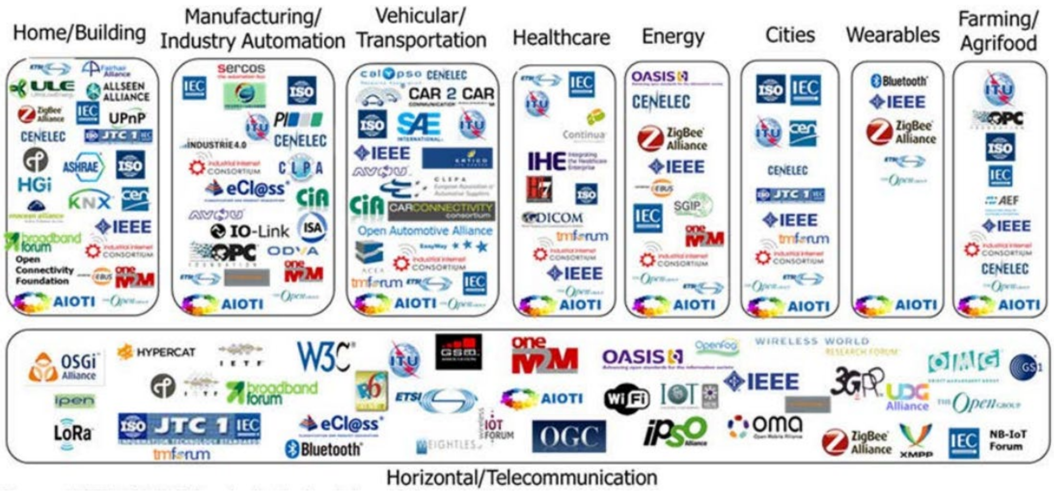
10 https://www.wired.com/insights/2014/07/internet-things-will-disrupt-everything/ (accessed 30.07.2023).

3. THE ROLE OF STANDARDISED TECHNOLOGY FOR IOT CONNECTIVITY

3.1. Standard landscape

10. The IoT's impressive growth momentum rests by and large on a great variety of technology standards enabling interoperability of IoT devices within and across sectors. Many IoT devices rely on standardized technologies common to various IoT applications. These "horizontal" standards typically ensure connectivity between many different types of IoT devices. An example would be cellular standards such as LTE-M and NB-IoT developed by the 3rd Generation Partnership Project (3GPP) as well as the Wi-Fi standard developed by IEEE as shown in Figure 4 below.

Figure 4: IoT Standardisation landscape



Source: European Telecommunications Standards Institute (2016): Technical Report. Smart M2M; IoT Standards landscape and future evolutions. Page 14. Available at: https://www.etsi.org/deliver/etsi_tr/103300_103399/103375/01.01.01_60/tr_103375v010101p.pdf (accessed 30.07.2023).

11. Choosing a connectivity standard for IoT devices depends on a combination of factors. These include signal range, reliability, maximum bandwidth requirements (throughput) and power usage. For instance, NFC, Bluetooth or ZigBee offer short range connectivity with low power usage. Wi-Fi enables a medium range connectivity with higher throughput rates. LoRa, Sigfox, NB-IoT and LTE-M offer low power wide area (LPWA) communication with relatively low throughput rates. In contrast, the 3G, 4G, and 5G standards offer long range connectivity with higher throughput rates. Multiple connectivity standards may be incorporated in the same device.

3.2. Cellular standards

12. Cellular and Wi-Fi are the main royalty bearing connectivity standards across IoT applications, with the former making up the great majority of SEP licensing disputes in recent years, pointing towards unaddressed frictions in the cellular SEP licensing

landscape (see Section 4 below).[11] With the advent of 5G and the expansion of potential applications for cellular standards in the IoT,[12] discussions around cellular SEP licensing have gained additional importance. For these reasons, in the following we focus on the licensing of cellular standards in the context of the IoT. However, the key insights will translate directly to other standards with a similar licensing structure and potential licensee landscape.

13. Based on a sample of almost 800 cellular IoT projects from around the world, Figure 5 shows the variety of applications of installed IoT end device units ("connections"). Globally, the largest shares of cellular IoT connections in 2020 relate to automotive applications[13] (38%, with 30% factory installed by OEMs and 8% retrofitted in the aftermarket), devices used for transport and logistics (22%) and utilities (20%). In terms of installed IoT connections, utilities and OEM/aftermarket automotive applications were also the most relevant cellular IoT applications in the UK, accounting for 37% and 31% of connections, followed by devices related to buildings and security (15%), and transport and logistics (13%). While still having a smaller number of connections, cellular SEPs are also used in healthcare, retail, industrial, infrastructure and consumer electronics applications (included in the category "Others" in Figure 5).

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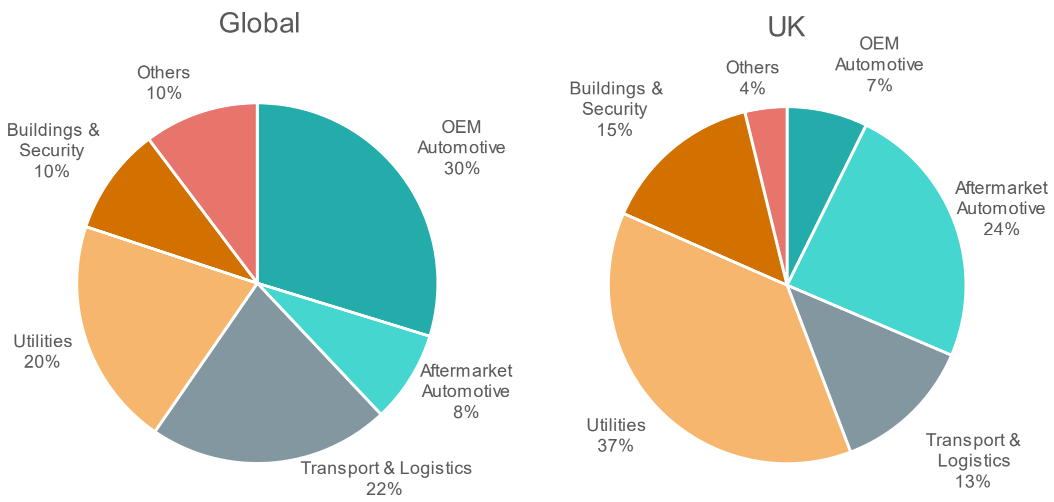
11 Slide 7 of a presentation by IPLytics showing the percentage of various standards subject to litigation in the last 20 years (2001-2021) including cellular 76.42% and Wi-Fi 2.06%, available at https://www.iplytics.com/wp-content/uploads/2021/03/SEP-Litigation-Trends-and-Licensing-Realities-IPWatchdog-and-IPlytics-March-2021.pdf (accessed 30.07.2023) and https://www.ipwatchdog.com/2021/04/28/sep-litigation-trends-data-say/id=132727/ (accessed 30.07.2023). The "Empirical Assessment of Potential Challenges in SEP Licensing" prepared by IPLytics for the European Commission in 2023 (p. 75) shows that for cellular and Wi-Fi standards, litigants' views of what constitutes a FRAND value are particularly divergent.

12 The advent of 5G marks a landmark in broadening the scope and potential of IoT in the years to come, ranging from autonomous cars to remote healthcare. This potential has also been recognised by the UK Government which has articulated plans to foster 5G development in order to enable "thousands more 'smart' devices on the street which connect to the internet and each other". Press release by the Department for Digital, Culture, Media & Sports of 08.02.2022, Julia Lopez MP. Available at https://www.gov.uk/government/news/new-plans-to-slash-red-tape-from-5g-roll-out-and-improve-mobile-phone-connectivity (accessed 30.07.2023).

13 These connections refer to components that automotive OEMs receive from suppliers and install in the vehicle such as telematic control units.

Figure 5: Global vs UK connection unit share by cellular IoT application 2020



Source: Berg Insight Reports, 2021: "The 500 Largest Cellular IoT Projects Worldwide" and "300 Emerging Cellular IoT Projects Worldwide".

4. LICENSING ISSUES FOR CELLULAR SEPS IN THE IOT

Cellular technologies made up the great majority of SEP licensing disputes in recent years, pointing towards unaddressed frictions. While most cellular SEP licensing disputes in the past were centred around mobile phones, in recent years licensing disputes upended the automotive vertical, and SEP holders' activities to monetize other IoT verticals have stepped up in recent months. In this section, we show how the IoT licensing landscape exacerbates cellular SEP licensing issues.

14. We first identify the main potential licensors and pools active in cellular SEP licensing and characterise potential licensees which may be targeted by SEP holders at different levels of the value chain (Section 4.1). Due to patent exhaustion, an SEP that is used in a component of an end device generally needs to be licensed only once, i.e., either downstream by the manufacturer of the end device <u>or</u> upstream by the component supplier. Major SEP holders insist on licensing cellular SEPs at the end device level.[14]

15. In addition to the elevated (and potentially non-FRAND) royalties that can emerge from end device licensing, efforts by SEP holders to license at the end device level will result in enormous transaction costs for negotiating licences for the IoT (Section 4.2). The total transaction costs incurred for the licensing of cellular SEPs depend on the number of licensing negotiations and the number of potential licensing disputes, which in turn are determined by the numbers of SEP licensors and licensees. The number of small and medium-sized enterprises ("SMEs") requiring SEP licences at the end device level will likely be much larger than in the industries where licensing of cellular SEPs has traditionally taken place. Quantifying SEP licensing transaction costs shows that these may be prohibitive for

14 A reason for this practice for SEP holders is to obtain higher royalties. A Qualcomm executive testified in FTC v Qualcomm that licensing on the OEM level is "humongously more lucrative" (FTC v Qualcomm No. 5:17-cv-002200, 2019 U.S. Dist. WL 2206013).

smaller UK businesses and even risk undermining the business model of larger companies active in the IoT. Our simulation shows that around 99% of these transaction costs could be saved if SEP licensing takes place at the component level.

4.1. Parties involved in SEP licensing

16. In this section, we identify the main potential licensors and pools active in cellular SEP licensing. We also characterise the pool of potential licensees in the IoT which may be targeted by SEP holders at different levels of the value chain. Under the current licensing framework, SEP holders have incentives to approach UK businesses further down the value chain who lack both SEP licensing experience and the financial resources to engage in SEP negotiations or defend themselves in court.

4.1.1. Cellular SEP holders

17. To assess the number of potential licensors, we have obtained a list of SEP holders that have declared essential patents for any of the cellular standards (2G, 3G, LTE, 4G, 5G etc.) from the public database of the European Telecommunications Standards Institute (ETSI).[15] Accounting for changes in the ownership of SEPs, this gives us a list of more than 100 potential SEP holders for cellular standards.

18. Instead of licensing their patents on their own SEP holders may decide to join a patent pool that manages the licensing process on behalf of its members. However, since pools generally do not include the entire stack of SEPs that have been declared relevant to a standard, potential licensees typically still need to negotiate with both pool administrators and individual SEP holders that do not participate in a pool.

19. Depending on the IoT vertical, potential licensees could choose to license a part of the cellular stack through pools.[16] There are currently two pool operators offering licensing programmes to cellular standards for the IoT: Avanci and Sisvel.[17]

20. Avanci currently offers four licensing programmes for IoT application.

- The Vehicle 4G programme[18] offers a licence to automotive OEMs for eCalls ($3/vehicle), 3G ($9/vehicle) and 4G ($20/vehicle). The 4G rate has been increased by more than 30% from $15 for licensees that joined the pool after 1 September 2022.[19] As of July 2023, the pool counted 56 licensors.

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15 https://ipr.etsi.org/ (accessed 30.07.2023).

16 While pools may help reduce transaction costs, multiple competition risks associated with pools have been raised, in particular with respect to Avanci. See, e.g., Jurata & Luken (2021).

17 The pool operator Via has recently decided to end its LTE licensing program (https://www.iam-media.com/article/licensing-ending-wireless-patent-pool-double-down-audio-codec-programmes, accessed 30.07.2023). For this reason, we do not count the Via pool as a licensor in our simulation, conservatively assuming that in the future all Via licensors will join Avanci and/or Sisvel instead of individually licensing their cellular SEPs.

18 https://www.avanci.com/vehicle/4gvehicle/ (accessed 25.07.2023).

19 https://www.juve-patent.com/news-and-stories/people-and-business/avanci-increases-licensing-rate-for-4g-automotive-programme/, (accessed 30.07.2023).

- The Vehicle 5G programme was launched in August 2023 with a pool rate of $29 for OEMs signing a licence before the later of 16.02.2024 or the first sale of a 5G connected vehicle and $32 otherwise.[20]
- The Aftermarket programme[21] has been launched at the beginning of 2023 as an extension of the Vehicle 4G licensing programme. The pool offers a licence for a range of IoT devices, related in particular to vehicle telematics including "infotainment devices" ($15 / 4G devices), "monitoring products" ($4 / 4G device), "multi-function devices" ($7.5 / 4G device). As of July 2023, the pool covered 42 SEP holders which are all also members of the Vehicle 4G programme.
- The Smart Meter programme[22] has also not yet fully materialized as of July 2023 and no rates or pool members have been published.

21. Sisvel launched its cellular IoT pool in November 2022 and counts 22 SEP holders as of July 2023. It offers a licence for NB-IoT devices ($0.66 / device), as well as smart meters ($2 / device) or asset trackers ($1.33 / device) reading on the LTE-M standard.[23]

22. Huawei announced royalty rates for its handsets, Wi-Fi, and IoT patent license programmes in July 2023. For Huawei's cellular IoT patent licensing programme, the rate for IoT-Centric devices is one percent of the net selling price, capped at $0.75, while the rate for IoT-Enhanced devices ranges from $0.3 to $1 per unit.[24]

23. To arrive at the number of potential cellular licensors, we first account for pool membership. We conservatively assume that all SEP holders currently participating in the Avanci Vehicle or the Sisvel IoT pools as well as former Via licensors will license through an Avanci or Sisvel licensing programme. We therefore count both pools and all their members as two separate potential licensors. We further identify 8 additional cellular SEP holders for which we can confirm the existence of a cellular licensing programme. We also conservatively assume that major cellular SEP holders such as Apple, HTC, LG, Xiaomi, and Vivo, which to our understanding have not yet actively approached implementers with royalty claims, will not do this in the foreseeable future. This leaves us with at least 10 potential cellular licensors. This is certainly a conservative, lower bound estimate for the actual number of potential licensors in the cellular IoT sector.[25]

24. Depending on the specific IoT vertical, the actual number of potential licensors can be much higher. It remains to be seen if in the future there will be licensing programmes that will indeed attract the same number of licensors as the Avanci 4G Vehicle pool and the Sisvel

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20 https://www.avanci.com/2023/08/16/avanci-launches-5g-connected-vehicle-licensing-program/ and https://www.avanci.com/vehicle/5gvehicle/ (accessed 21.08.2023).

21 https://www.avanci.com/vehicle/aftermarket/ (accessed 25.07.2023).

22 https://www.avanci.com/iot/smart-meters/ (accessed 25.07.2023).

23 https://www.sisvel.com/licensing-programs/wireless-communications/cellular-iot/introduction (accessed 25.07.2023).

24 https://www.huawei.com/en/news/2023/7/ipr-innovation-horizon (accessed 23.08.2023).

25 It has been reported that a total of 48 telecommunications technology developers have demanded that automakers Toyota, Honda and Nissan pay them patent fees for components used to connect their vehicles to the internet. See https://www.futurecar.com/5172/Qualcomm-Nokia-and-Others-Demand-Patent-Fees-From-Toyota-Honda-&-Nissan-for-Using-Their-4G-5G-Communications-Technology (accessed on 30.07.2023).

IoT pool. It is quite possible that either pool will only cover a subset of the current licensors of the 4G Vehicle programme and the IoT programme, respectively. This would increase the number of SEP holders in the respective verticals accordingly. Moreover, several of the SEP holders participating in the 4G vehicle pool have not yet confirmed that they will also be joining the 5G vehicle pool.[26]

25. It should also be noted that the licensing landscape for 5G has not fully materialized yet and it is likely that further firms will declare to hold SEPs for the 5G standard. The number of cellular SEP holders might thus further increase in the coming years.

4.1.2. Component manufacturers

26. In practice, a product value chain typically consists of several levels. A component in which a standard is implemented might be integrated in other larger components before becoming part of an end device. In the context of cellular devices, two types of components are particularly relevant:[27]

- The cellular **chipset** controls the radiofrequency tasks needed to enable a smart device to connect to and transmit data through a cellular network.
- The cellular **module** comprises the cellular chipset and adds other features like a processor, memory, a place to supply power, an antenna port, and module level certifications.

27. Whether it is preferrable for an end device manufacturer to integrate chipsets or modules into its IoT products depends primarily on the volumes involved.[28]

28. For the sake of simplicity, we abstract from these different levels of the supply chain and assume in the following that a cellular SEP is either licensed at the end device level or at the chipset level, even though it could in theory also be licensed at the module level. We will see in the following, that there are somewhat more module manufacturers than chipset makers active in the IoT market. Component level licensing at the chipset level would thus be particularly efficient from a transaction cost perspective. We will thus consider the number of component suppliers for the calculation of transaction cost at the component level. Below we show that the number of end device manufacturers exceeds the number of chipset or modem manufacturers by several orders of magnitude. For the comparison with transaction costs accruing from SEP licensing at the end device level, it does not matter whether the number of chipset or module manufacturers is considered in the following.

Cellular IoT chipset manufacturers

29. Eight major cellular IoT chipset manufacturers make up around 90% of the market in terms of global unit sales (2022 Q4). Five out of the top eight chipset manufacturers are based in

26 https://www.iam-media.com/frand/avanci-lg-deal-ericsson-qualcomm-nokia-5g (accessed on 30.07.2023).

27 A third level is a **modem,** which will incorporate the module and add a range of features like more hardware interfaces, application software, a SIM card slot, on-board modem control unit, other wireless protocols, and end device certification. IoT modems are less relevant for this report, as the high-volume products we focus on typically integrate either chipsets or modules, not modems.

28 Designing from the cellular chipset provides more flexibility but entails higher fixed integration and certification costs and normally only makes sense when product volumes exceed 250,000 units, while modules normally make sense when production volumes are above 50,000. https://www.lairdconnect.com/resources/white-papers/cellular-iot-modem-vs-module-navigating-crucial-decision-iot-design-projects (accessed on 30.07.2023).

China or Taiwan (e.g., UNISOC, ASR Microelectronics) accounting for more than 45% of the market. With Qualcomm, 40% accrues to US companies. Sequans (2%) is the only European company featured in the list. There are no major UK manufacturers of IoT chipsets.

30. It can be reasonably assumed that cellular licensing at the component level in the IoT would be centred around these eight dominant players, roughly covering around 90% of the market. To present a generalized overview, we ignore smaller potential chipset vendors.

Table 1: Cellular IoT chipset vendors – 2022Q4 shipment volume share

Company	2022 Q4 Shipment share
Qualcomm	40%
UNISOC	20%
ASR	9%
Eigencomm	7%
Xinyi	6%
MediaTek	5%
Sequans	2%
Sony	2%
Others	8%
Total	**100%**

Source: https://www.counterpointresearch.com/global-cellular-iot-module-shipments-2022/ (accessed 25.07.2023)

Cellular IoT module manufacturers

31. Considering the largest cellular IoT module manufacturers as of 2022 Q4, there are 10 vendors accounting for almost 80% of global shipments. Chinese module makers Quectel, Fibocom, CMCC-IoT, SunSea, MeiG and Neoway made up around two thirds of total shipments. Ublox, the largest European manufacturer in the list, accounted for around 2%. The group of "Others" is comprised of smaller module manufacturers such as European manufacturers Nordic Semiconductors (Norway) and Sequans (France). As with chipsets, there are no major UK based module vendors active in the IoT market. Some cellular modules are vertically integrated and produce their own chipsets which are then integrated into their cellular modules.

32. The number of module makers covering 90% of the market is thus somewhat greater than the number of chipset makers. In principle, component level licensing could also be implemented at the IoT module level. However, the difference in the number of chipset versus module manufacturers is immaterial compared to the number of downstream innovators as shown below.

Table 2: Cellular IoT module vendors – 2022Q4 shipment volume share

Company	2022 Q4 Shipment share
Quectel	39%
Fibocom	8%
Telit Cinterion (incl. Thales)[29]	8%
CMCC-IoT	5%
SunSea	5%
MeiG	4%
Neoway	3%
Sierra Wireless/Semtech[30]	3%
Ublox	2%
Others	22%
Total	**100%**

Source: https://www.counterpointresearch.com/global-cellular-iot-module-shipments-2022/ (accessed 25.07.2023)

4.1.3. Downstream IoT innovators

33. The IoT sector is highly fragmented with a myriad of device manufacturers and developers of different sizes competing in each product area. The sheer number of potential applications and innovation opportunities offered by the IoT has led to a constant inflow of new start-ups.

34. The significant number of applications makes it naturally challenging to provide a precise and reliable estimate of the number of firms that use cellular SEPs in their IoT devices. However, to illustrate the order of magnitude, we derive a ballpark estimate based on the aforementioned sample of nearly 800 cellular IoT projects.

- **Dataset I – 500 largest cellular IoT projects:** The 500 largest IoT projects worldwide, as identified by Berg Insight[31], are run by 483 different companies and accounted for 24.1% of the total global cellular IoT connections[32] at the end of 2020.
- **Dataset II – 300 emerging cellular IoT projects:** Berg Insight has further identified 300 emerging cellular IoT projects with a low number of current connections (less than 50,000 at the end of 2020), accounting for less than 1% of total connections worldwide, but with strong growth potential.

35. Based on the Berg Insight selection of the top 500 largest and the top 300 emerging projects, the UK hosts the second largest number of cellular IoT OEMs globally after the

29 In December 2022, Telit acquired Thales's cellular IoT products business (the combined company is called Telit Cinterion). See https://www.thalesgroup.com/en/worldwide/security/press_release/telit-and-thales-announce-creation-leading-western-iot-solutions (accessed 17.08.2023).

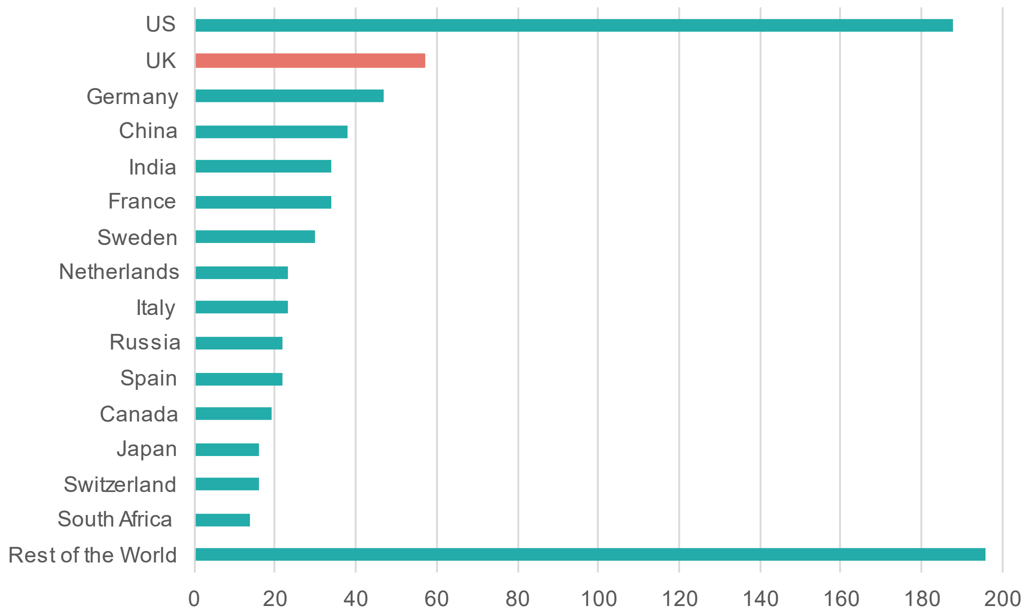
30 In January 2023, Semtech acquired Sierra Wireless. See https://www.semtech.com/company/press/semtech-corporation-completes-acquisition-of-sierra-wireless (accessed 17.07.2023).

31 Berg Insight is a leading global industry analyst and consultancy specialized in the IoT and digital technologies.

32 An IoT connection is defined as an active, connected IoT device.

US. Additional top host countries in terms of the number of OEMs are Germany, China, India, and France.

Figure 6: Number of IoT OEMs by country of headquarters



Source: Berg Insight Reports, 2021: "The 500 Largest Cellular IoT Projects Worldwide" and "300 Emerging Cellular IoT Projects Worldwide".

36. Taken together, the two datasets include 769 distinct companies whose projects account for 24.4% of the total number of worldwide cellular IoT connections. The total number of UK firms is 57. To derive an estimate of the number of cellular IoT firms with which SEP holders would have to reach a licensing agreement in order to cover 90% of all IoT connections, we assume that the average number of connections per firm is the same as in the combined dataset of the 500 largest and 300 emerging cellular IoT projects. In other words, we scale up the number of firms proportional to the share of IoT connections. The estimated total number of downstream IoT innovators that account for 90% of connections is thus 2,839. Assuming that the share of UK firms in the Berg Insight datasets is representative of the entire cellular IoT space, the number of UK firms is estimated to be 210.

Table 3: Estimated number of IoT firms

	Number of firms – global	Number of firms – UK
Berg Insight (500 largest and 300 emerging cellular IoT projects)	769	57
Firms accounting for 90% of total cellular IoT connections (imputed)	2,839	210

Source: Berg Insight Reports, 2021: "The 500 Largest Cellular IoT Projects Worldwide" and "300 Emerging Cellular IoT Projects Worldwide".

37. In case of device level licensing, SEP holders would thus face a much greater number of potential licensees in the IoT than for "traditional" mobile telecommunications, where

cellular SEP licensing has primarily taken place thus far. For instance, if a cellular SEP holder wanted to collect royalties (and/or benefit from cross-licences) from manufacturers representing 90% of smartphone sales, they would need to enter into licensing agreements with only 15 manufacturers.[33]

38. The number of cellular IoT innovators can be further expected to grow massively in the coming years due to market expansion and new entries.[34]

4.2. Inefficiently high transaction costs

39. In this section, we estimate the total aggregate transaction costs related to SEP licensing that downstream innovators using a standard might incur. To assess the impact of the licensing level on transaction costs, we estimate these costs for a scenario in which SEP holders license their cellular SEP to IoT device makers and compare with an alternative scenario in which the SEP licences would be taken out by the IoT chipset vendors.

40. We recognise that our parameter estimates are subject to material uncertainty, implying that the resulting transaction cost estimates are also uncertain. However, even if the actual transaction costs per licensing negotiation or litigation dispute were to differ from the values considered below, our main finding of significantly lower transaction costs at the component level remains valid because it is driven by fewer negotiations. And thus, also the qualitative results hold over a wide range of transaction costs per licensing negotiation/litigation dispute.

4.2.1. Main parameters for SEP licensing transaction costs

41. For the purpose of this simulation, we focus on the transaction costs accruing to downstream innovators and assume that these transaction costs consist of costs for negotiating licensing agreements and potential litigation costs in case of licensing disputes. Negotiation and litigation costs are each solely based on two parameters. Negotiation costs depend on the total number of negotiations and the average transaction cost per negotiation. Litigation costs analogously depend on the number of licensing disputes and the average costs per dispute. In order to capture substantial heterogeneity in the litigation costs, we consider a range of values for this parameter.

42. We find that the level of estimated transaction cost in case of device level licensing may severely undermine the business model of SMEs in the IoT sector. The goal of our simulation is not however to provide a precise estimate of the *actual* transaction cost associated with the licensing of cellular SEPs in the IoT sector. Rather, the high estimated transaction cost in a device level licensing scenario indicates that if licensing in the IoT sector were to occur at the end device level, other parameters would have to be changed in order to ensure that potential licensees of cellular SEPs in the IoT sector remain viable. SMEs may of course take measures to minimise transaction costs from SEP licensing, such as by accepting onerous licence terms with a view to avoiding litigation. While such coping behaviour may reduce the downstream firms' potential litigation costs, this may result in

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33 See Statista based on counterpoint research, available at https://www.statista.com/statistics/668604/global-smartphone-shipments-by-vendor/ (accessed 29.07.2023).

34 Transforma Insights estimates that there are almost 2bn global cellular IoT connections in 2023 and expects this number to grow to around 5bn by 2030, see https://transformainsights.com/research/forecast/highlights (accessed 30.07.2023).

inflated royalty rates and ultimately again compromise the competitiveness of the IoT sector.

Number of licensing negotiations and disputes

43. The number of licensing negotiations naturally depends on the number of potential licensees and the number of SEP holders. As described in Section 4.1.1, we have identified 11 potential licensors for the IoT. This covers only licensors that have been identified to offer a cellular licensing program.

44. We reiterate again the number of potential licensees upstream and downstream in the IoT sector as derived in the preceding sections:

- **Number of potential licensees upstream (relevant for component level licensing):** We have identified eight cellular IoT- and three smartphone chipset vendors. As established, these are the key vendors making up for more than 90% of global chipset unit sales/revenue.
- **Number of potential licensees downstream (relevant for device level licensing):** Based on a sample of almost 800 cellular IoT projects, we estimate that there are at least 2,839 manufacturers of cellular IoT devices that together account for 90% of all IoT connections; with around 210 of them – or around 7% – being based in the UK.

45. With respect to the number of licensing disputes, we consider two scenarios with different assumptions on the probability that a negotiation results in litigation: while in the first scenario only 5% of licensing negotiations end up in litigation, we assume in the second scenario that disputes occur more frequently, namely in every fifth negotiation (i.e., 20%).

46. Recent empirical and survey evidence suggests that the probability of litigation may be much higher than 20%. First, Baron et al. (2023) assesses the incidence of litigation across different segments of SEP licensors. Litigation incidence is found to be highest for patent assertion entities (PAEs) for which the study finds that the number of SEP litigations per SEP licence is on average higher than 1.[35] For patent pools, the report estimates a maximum of 0.1 SEP litigations per pool licence, which is also consistent with the two scenarios that we consider. For major net licensors, the report estimates a maximum 0.01-0.03 SEP litigations per SEP licence, but this data point is less relevant for our analysis, as we conservatively assume that the SEPs of the major SEP holders can be licensed through pools. Second, the UK IPO conducted a survey regarding SEPs among small and medium-sized enterprises. Among 12 respondents that are involved in SEP licensing, 9 (75%) stated that they had disagreed with the terms of a licence or the rate that has been offered, and 6 (i.e., 50% of 12 respondents) stated that the dispute led to litigation.[36] Lastly, there is also anecdotal evidence that the incidence of litigation may be higher than the scenarios that we consider. The first cross-licence between Ericsson and Samsung was signed in 2001 shortly after Samsung had, for the first time, entered the market for GSM with its own products.[37] After that licence expired in 2005 and the parties were unable to reach

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35 The 2016 report "Patent Assertion Entity Activity: An FTC Study" finds that PAEs have concluded 2,715 licence agreements over a study period of six years and initiated 2,452 lawsuits. This translates to 0.9 litigations per licence.

36 UK IPO (2023), questions 23 and 26.

37 https://www.iam-media.com/frandseps/ericsson-samsung-stasik-new-strategy (accessed 30.07.2023).

agreement on a renewal, Ericsson sued Samsung for patent infringement in 2006 in the UK, Germany, the Netherlands, and the United States ITC. This litigation ended when the parties concluded a licence agreement in 2007. When that agreement expired in 2012, another flurry of litigation between Samsung and Ericsson relating to GSM, UMTS and LTE standards began and was settled in 2014.[38] In 2019, Ericsson and Samsung started negotiations for a new licence agreement that would include 5G as well as the previous cellular standards.[39] In December 2020, Samsung filed a complaint against Ericsson in China and asked the Chinese court to determine a global rate, while Ericsson filed suit against Samsung in the US.[40] The two firms eventually signed a global patent licence agreement in 2021.[41] During the past 15 years, litigation between Ericsson and Samsung therefore occurred (i) *every time* new licensing agreements were negotiated, that is, on average every six to seven years, and, (ii) typically involved multiple jurisdictions.

47. In our simulation, we estimate the average transaction cost downstream innovators incur from a single licensing negotiation and a possible dispute with each SEP licensor. In practice, downstream innovators who use cellular standards typically incur these transaction costs not only once but on a recurring basis. Indeed, cellular standards are evolving over time with new generations being released on a regular basis, roughly every eight to ten years. For example, downstream innovators who have licensed the 4G standard have to engage in new negotiations (and possibly disputes) to take out licences for the next generation of the standard, i.e., 5G. The estimates derived below should therefore be seen as a lower bound for the transaction costs incurred per cellular standard generation.[42]

48. In any event, we are likely to severely underestimate the actual transaction cost for the following additional reasons:

- First, SEP licensors usually only license their SEPs for limited time periods, which means that licences for the same standard and even for the same generation may need to be renewed.[43]

38 https://www.essentialpatentblog.com/2013/01/ericsson-files-sep-related-claims-against-samsung/ and https://www.fiercewireless.com/wireless/samsung-to-pay-ericsson-settlement-over-patent-dispute (both accessed 30.07.2023).

39 https://legal-patent.com/patent-law/swords-drawn-around-5g-ericsson-sues-samsung/ (accessed 30.07.2023).

40 https://www.essentialpatentblog.com/2021/01/judge-gilstrap-preliminary-enjoins-samsung-from-using-chinese-case-to-interfere-with-u-s-case-ericsson-v-samsung/ (accessed 30.07.2023).

41 https://www.ericsson.com/en/press-releases/2021/5/ericsson-and-samsung-sign-global-patent-license-agreement (accessed 30.07.2023).

42 Baron et al. (2023) estimate that an average patent licence lasts no longer than 8 years.

43 Our simulation also abstracts from possible effects of increasing fragmentation due to the sale of patents to other companies, including Non-Practicing Entities (NPEs), which could lead to a further increase of transaction costs.

- Second, downstream innovators and licensors might not agree on a worldwide licence but instead engage in separate licensing negotiations for different jurisdictions. In addition, patent infringement actions are filed in national courts. Hence, even if the parties negotiated over a worldwide licence, one negotiation can still give rise to multiple disputes in different jurisdictions – as illustrated by the Ericsson/Samsung example above– and thus lead to a multiplication of the litigation costs assumed in our simulation.

Average transaction cost per licensing negotiation

49. Only very limited information on the average transaction cost per SEP licensing negotiation is publicly available. Given the general lack of transparency and the confidential nature of many licensing agreements, this is not surprising. In practice, licensees will bear a mix of in-house costs as well as costs for external legal and technical advice.

50. Baron et al. (2023) estimate that the average negotiation cost (excluding litigation) for a licence of over 20 SEPs is at €1m (which is approx. £852k[44]) for both parties.[45] Assuming licensees carry about half of the negotiation costs, we base our simulation on estimated costs of £400k per licensee and per negotiation. We assume that this figure applies to negotiations at the component level. To capture that end-device OEMs might have less resources to negotiate with SEP holders, we conservatively assume negotiation costs of £200k at the end device level.

Average litigation cost per licensing dispute

51. We base our simulation on the reported litigation costs in recent UK SEP cases. In *Unwired Planet v Huawei*, the parties' reported costs for a technical patent trial in 2016 were £2.5m (Unwired Planet), £2.7m (Huawei) and £2.2m (Samsung).[46] The cost for the FRAND trial between Unwired Planet and Huawei one year later was even higher at £19.4m (£12.4m for UP and £7m for Huawei).[47] The cost of the FRAND trial in *InterDigital v Lenovo* was in excess of £31m (£17.25m for InterDigital and £14.27m for Lenovo).[48] The main reasons for high costs of SEP litigation include the need for multiple trials (at least one technical trial to determine whether there is a valid and infringed SEP and then a non-technical trial to determine what is the FRAND licence), as well as the need for extensive disclosure and

44 Based on the 2022 Euro to British Pound exchange rate of 0.8528 (https://www.exchangerates.org.uk/EUR-GBP-spot-exchange-rates-history-2022.html, accessed 24.08.2023).

45 Based on Lemley (2020), they assume that the average cost per patent in the negotiation is approximately $50k for the first 20 SEPs. They estimate that the average negotiation cost for licences for large implementers using large SEP portfolios may fall in a relatively large range between 1 and 10m Euro (which is approx. between £852.8k and £8.52m. Heiden and Petit (2017) estimate the mean cost of negotiating a SEP license (presumably to one party) in the U.S at $0.3m or £0.26m (ranging from $0.1 to 0.5m or £0.085m to £0.43m); and in the EU/China at $0.15m or £0.13m (ranging from $0.05 to 0.25m or £0.043m to £0.21m in the EU, and from $0.1 to 0.2m or £0.085m to £0.17m in China).

46 *Unwired Planet v Huawei* [2016] EWHC 410 (Pat), para 16.

47 *Unwired Planed v Huawei* [2017] EWHC 1304, para. 40.

48 *InterDigital v Lenovo* [2023] EWHC 1578 (Pat), para. 35.

expert evidence, and examination of this disclosure and evidence.[49] We will see that our main qualitative conclusions are largely independent from the level of litigation costs. Since SEP litigation costs outside of the UK tend to be somewhat lower than in the UK, and because we also compute global SEP licensing transaction costs, we conservatively assume that average litigation costs lie between £3m and £15m on the component level.[50] For licensing disputes of IoT device manufacturers, we base our estimations on a range from £2m to £15m, capturing that some end device OEMs might face tight budget constraints. Of course, companies with tight budget constraints might have reduced chances to prevail in court (see Section 4.3). We are also conservative in basing our litigation cost estimates on the costs of litigation in a single jurisdiction, while Baron et al. (2023) documented that SEP licensing disputes often give rise to multiple litigations before different courts.

Summary of key parameters

52. Table 4 summarizes the key parameters for estimating the transaction costs related to cellular SEP licensing in the IoT.

49 There are also estimates for patent litigation in the UK more generally. McDonagh and Helmers (2013) find that the average cost of a full trial at the PHC (Patent Court) falls between £0.5m and £3.0m per party based on a sample of 18 cases filed from 2000 to 2008. According to Cremers et al. (2013), the estimated costs of a case which reaches trial are around £1.5m for each side. While these estimates still show that litigation costs in the UK are material, litigation costs of SEP cases tend to be much higher, among other because of the technical difficulty of the patents in suit and the additional costs of the FRAND trial.

50 For the US, the American Intellectual Property Association (AIPLA) 2021 Economic Survey estimates litigation costs of £561k for a litigation value below $1m and £2.711m for litigations with $10m to $25m litigation value.

Table 4: Key parameters of transaction costs – Cellular IoT

Parameter	Cellular IoT
Avg. transaction cost of licensee per licensing negotiation - end device level (£)	200k
Avg. transaction cost of licensee per licensing negotiation – component level (£)	400k
Avg. cost per litigation of licensee - end device level (£)	2m – 15m
Avg. cost per litigation of licensee - component level (£)	3m – 15m
Avg. # Licences per licensee - end device level	5
Avg. # Licences per licensee - component level	10
Number of licensees at the component level (cellular chipset vendors)	8
Number of licensees at the end device level (device makers) – Global	2,839
Number of licensees at the end device level – UK	210

Source: CRA based on Berg Insight and Baron et al. (2023).

4.2.2. Estimating transaction costs under end device licensing

53. Based on the key parameters from Table 4, we estimate the collective total negotiation and litigation costs incurred by downstream innovators in case of device or component level licensing in the IoT. After aggregating negotiation and litigation costs, we finally assess to what extent the total transaction costs from SEP licensing differ between device and component level licensing.

Estimating total negotiation costs from SEP licensing

54. The industry-wide amount of transaction costs for negotiating cellular SEP licences can be calculated as the number of licensing negotiations multiplied by the average costs per negotiation. The number of licensing negotiations is the product of the number of SEP licensors and – depending on the licensing level – the number of chipset vendors or the number of device makers.

55. The estimated negotiation costs for potential licensees in the IoT under device and component level licensing are summarized in Table 5. Under device level licensing, our simulation approach results in estimated total negotiation cost from cellular SEP licensing of around £2,839m[51] for the global IoT sector, of which around £210m is borne by UK

51 $£200{,}000 \times 5 \times 2{,}839 = £2{,}839m$.

device manufacturers. Negotiation cost for component suppliers in the IoT are estimated at a miniscule fraction of the cost for end device manufacturers.[52]

Table 5: Negotiation cost simulation end device v. component level licensing for the IoT

Collective negotiation costs of licensees	Global	UK
End device level (£m)	2,839	210
Component level (£m)	32	2.4

Source: CRA calculations based on Table 4.

Estimating total litigation costs from SEP licensing

56. In addition to negotiation costs, litigation costs make up a substantial part of the total transaction cost related to SEP licensing. In our simulation approach, we estimate total litigation cost for two scenarios. As stated above, in the first scenario we assume that 5% of licensing negotiations result in licensing disputes, while in the second scenario we assume a higher probability of a licensing dispute of 20%. Moreover, we consider a range of £2m (£3m) up to £15m for end device level (component level) litigation.

57. Global end device level SEP litigation cost for licensees in the IoT will amount to around £1.4bn - £10.6bn[53] assuming 5% litigation probability, and between £5.7bn – 42.6bn assuming 20% litigation probability. Similarly, collective litigation costs in the IoT for all potential licensees in the UK are estimated between £105m - £787.5m and £420m - £3.2bn, assuming a 5% and 20% litigation probability, respectively. In both scenarios, litigation cost under component level licensing amounts to only a small fraction of the total litigation cost under device level licensing (see Table 6).

52 As we have not identified any major UK based cellular IoT chipset vendors, component level licensing would not lead to any direct transaction costs for UK firms. However, to not overestimate the transaction cost savings stemming from a shift from device to component level licensing, we conservatively assume that the transaction costs borne by foreign chipset vendors would be fully passed on to device manufacturers. Since around 7% of IoT device manufacturers are UK based, we assume that proportionally around 7% of transaction costs incurred by foreign chipset would be passed through to these UK based IoT firms.

53 $£2m \times 5\% \times 5 \times 2{,}839 = £1{,}419.5m$ and $£15m \times 5\% \times 5 \times 2{,}839 = £10{,}646.3m$

Table 6: Litigation cost simulation end device v. component level licensing

Scenarios	Collective litigation costs of licensees	Global	UK
5% litigation probability	End device level (£m)	1,420 - 10,646	105 - 788
	Component level (£m)	12 - 60	0.9 - 4.4
20% litigation probability	End device level (£m)	5,678 - 42,585	420 - 3,150
	Component level (£m)	48 - 240	3.6 - 17.8

Source: CRA calculations based on Table 4.

The impact of the licensing level on total transaction costs

58. The total transaction costs from SEP licensing are assumed to be the sum of negotiation and litigation costs as derived above. Table 5 below summarises the estimated transaction costs for potential licensees in the smartphone and IoT industries under device and component level licensing.

59. **Global transaction costs for SEP licensing in the IoT:** Assuming a 5% (20%) litigation probability, our simulation approach estimates total transaction costs for licensees from cellular SEP licensing at the end device level of around £4.3bn – £13.5bn[54] (£8.5bn – £45.4bn[55]) for the global IoT innovator landscape, for a single generation of cellular standards. In contrast, transaction costs for the IoT sector in the case of component level licensing are estimated to be only £44m - £92m (£80m - £272m), i.e., only 0.7% - 1% (0.6% - 0.9%) of the costs incurred under device level licensing.

60. **UK transaction costs for SEP licensing in the IoT:** Having assessed the impact of the licensing level on a global scale, we now turn to the estimate of transaction costs for UK-headquartered innovators. Under device level licensing, transaction costs for UK IoT device makers are estimated at £315m – £998m, assuming a 5% litigation probability – and around £630m - £3.4bn under a 20% litigation probability. This corresponds to average transaction cost of £1.5m – £4.8m under 5% litigation probability and £3m - £16m under 20% litigation probability per UK innovator.

61. The *collective* transactions costs for *all* UK IoT firms under component level licensing would only amount to £3.3m - £6.8m and £5.9m - £20.1m, assuming a 5% and 20% probability of litigation respectively – and thus be around 99% lower than under device level licensing.

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54 $£2{,}839m + £1{,}420m = £4{,}259m$ and $£2{,}839m + £10{,}646m = £13{,}485m$. Baron et al. (2023) estimate total *annual* licensing transaction costs of £171m-256m (EUR 200-300m) for licences with major SEP holders, £171m-341m (EUR 200-400m) for licences with PAEs and £341m-682m (EUR 400-800m) for patent pools (using the 2022 average annual exchange rate of 0.8528 from https://www.exchangerates.org.uk/EUR-GBP-spot-exchange-rates-history-2022.html, accessed 01.09.2023). Assuming 8 years per standard generation and that licensees bear about half of these costs, this amounts to about £2.7bn-5.1bn in transaction costs for licensees for one standard generation. Our estimate is higher, but is not comparable to the estimate by Baron et al. (2023), as we simulate the costs of cellular licences if licensing for the IoT were generally made at the end device level, while Baron et al. (2023) seek to estimate the *current* licensing transaction costs for all standards (where SEP holders have not yet approached many of the manufacturers active in the IoT).

55 $£2{,}839m + £\,5{,}678m = £8{,}517m$ and $£2{,}839m + £42{,}585m = £45{,}424m$.

This translates to average transaction cost of £15k - £32k and £28k - £96k per UK innovator.

Table 7: Transaction cost simulation end device v. component level licensing

Scenario	Collective transaction costs of licensees	Global	UK
5% litigation probability	End device level (£m)	4,259 - 13,485	315 - 998
	Component level (£m)	44 - 92	3.3 - 6.8
	Cost difference (∆) (£m)	4,215 - 13,393	312 - 991
	∆ (in % of end device level cost)	99.0% - 99.3%	99.0% - 99.3%
20% litigation probability	End device level (£m)	8,517 - 45,424	630 - 3,360
	Component level (£m)	80 - 272	5.9 - 20.1
	Cost difference (∆) (£m)	8,437 - 45,152	624 - 3,340
	∆ (in % of end device level cost)	99.1% - 99.4%	99.1% - 99.4%

Source: CRA calculations based on Table 4. Numbers may not fully add up due to rounding.

4.3. Material risk of hold-up

62. Licensing at the end device level will lead to more unbalanced negotiations and thus a higher likelihood of patent hold-up than licensing at the component level. In this section, we discuss three particularly important reasons. First, the licensed volumes at the end device level tend to be lower than at the component level. This discourages potential licensees from incurring costs to achieve more favourable licensing terms. Second, end device manufacturers may lack SEP licensing experience, expertise, and resources to properly evaluate and challenge the demands of SEP holders. Third, sunk investments per licensed unit tend to be higher at the end-device level. We discuss these issues in turn.

63. **Not worthwhile for small licensees to incur costs to obtain improved licensing terms**. Actions to obtain improved licensing terms are mainly of a fixed cost nature. The licensing value at stake has only a minor direct impact on the negotiation/litigation costs. For instance, litigation costs are mainly driven by the time and resources required to prepare submissions, prepare and participate in hearings, etc. On the other hand, the value of achieving more favourable licensing terms is very much driven by the volume. For instance, the total value of achieving a reduction by 10 cents per unit on an annual volume of 1m units is £100k, while achieving the same reduction per unit on an annual volume of 10m units is £1m. It can therefore be rational for a small firm to accept non-FRAND licensing terms to avoid fixed negotiation/litigation costs.

64. **Lack of SEP licensing experience, expertise, and resources.** End device manufacturers often lack both the understanding of the FRAND licensing process and the resources to meet SEP holders on equal terms. In addition, they also may not have the necessary technical understanding needed to evaluate the technologies in the standard and the validity of the SEP holder’s licensing claims. SMEs and start-ups can be intimidated by the possible consequences of patent infringement (e.g., facing an injunction) and thus be prone

to simply accept non-FRAND royalty demands instead of engaging in further negotiations. This is of relevance for the IoT arena which has led to continuous entry of new start-ups that implement standardised technologies in their IoT devices.[56] Recent academic research has confirmed that smaller firms face several issues which ultimately deteriorate their bargaining position. In interviews with 22 IoT firms with a focus on start-ups, Henkel (2022) found that end device manufactures often do not even know which or how many SEP holders could approach them.[57] This is also reflected in the UK IPO's recent SME survey.[58] Among the 12 respondents that were involved in SEP licensing, 83% stated that they did not have sufficient information on the pricing of SEPs that they licensed or might license in the future.[59] Among others, important reasons for this lack of information are that the rates agreed to by an SEP holder with other licensees are not disclosed and that it is difficult to get an accurate view of all potential licensors.[60] Moreover, SMEs and start-ups additionally face resource constraints that limit their opportunities to acquire technical and legal advice, and suffer even more than large component suppliers from cost and legal uncertainty. For example, the UK IPO's SME survey reveals that at least some smaller firms face financial risk entering SEP licensing and that the uncertainty around financial liabilities associated with SEPs may even influence the areas an SME invests in.[61]

65. Evidence from recent UK judgments has confirmed that smaller firms were coerced into licences at non-FRAND terms. First, in *InterDigital v Lenovo*, Mr Justice Mellor held that the rates charged by InterDigital discriminated against smaller licensees, contrary to the FRAND principles.[62] Second, in *Optis v Apple*, Mr Justice Marcus Smith disregarded the licences provided by Optis as probative comparable licences.[63] He noted that most counterparties were small companies and that there was an inequality of bargaining power.[64] Deriving the aggregate royalty burden from Optis' comparable licences showed that a large portion of the price of a handset would have to be paid to the SEP owners. Mr Justice Marcus Smith concluded that "*no implementer could stay in business paying Optis' rates*", which suggests that the royalty rates accepted by some of Optis' licensees are non-FRAND.[65] Inflated and discriminatory royalties can create an unlevel playing field between end device OEMs, and manufacturers that have to pay high SEP royalties may be disadvantaged against competitors that have been able to negotiate lower rates or are not targeted by SEP holders (e.g., because they sell a predominantly in countries where SEP enforcement is less stringent than in the UK).

56 https://iot-analytics.com/iot-startup-landscape/ (accessed 31.07.2023)

57 Henkel (2022).

58 UK IPO (2023).

59 *Ibid.*, question 18.

60 *Ibid.*, question 19.

61 *Ibid.,* question 31.

62 *InterDigital Technology v Lenovo* [2023] EWHC 539 (Pat) (16 March 2023), paras. 495 et seq.

63 *Optis v Apple* [2023] EWHC 1095 (Ch) (29 May 2023), para. 398 (iii).

64 *Ibid.*, para 470 (iii).

65 *Ibid.*, para 467 (iii).

4.4. IoT SEP licensing frictions are not yet fully visible

66. The SEP licensing developments in the automotive vertical illustrate what may be in store for the UK IoT sector. For decades, the automotive industry relied on component level licensing.[66] However, several SEP holders refused to license their SEPs at the component level and instead approached automotive OEMs, once it was in their commercial interest to do so. Soon, automotive OEMs that were previously unaffected by SEP licensing disputes found themselves in SEP litigation. The formation of the Avanci "Aftermarket" pool in the first half of 2023 suggests that history may repeat itself – this time targeting UK companies active in the vehicle telematics space, rather than car manufacturers.

67. SEP holders may have an incentive to wait until the use cases for cellular SEPs have materialised and IoT applications infringing on their IP have been widely deployed before asserting their patents. This increases the pool of potential licensees who have implemented the respective technology and are thus "locked-in" as well as the number of royalty-bearing units for which licensing fees can be charged retroactively (as observed by the Court recently in *InterDigital v Lenovo*[67]).

68. Disputes over the licensing of cellular SEPs in the automotive industry can serve as a cautionary tale of how an entire industry can be disrupted within a short time once SEP holders start to enforce their SEPs. After the formation of Avanci in 2016, a wave of litigation broke off.[68] First, in 2019, Daimler was sued by Nokia and three other Avanci members (Sharp, Conversant and IP Bridge) for patent infringement in Germany.[69] Second, Tesla was sued for patent infringement by Sharp, Sisvel, Conversant, and IP Bridge in Germany, Japan, and the US. Third, Volkswagen was sued by Acer and IP Bridge for infringement of 4G SEPs in Germany and the US.[70] Fourth, Longhorn IP sued Stellantis and Nissan for patent infringement in Germany.[71] Lastly, as many as seven SEP owners sued Ford for patent infringement in Germany and the US.[72]

69. Within a short period of time, most of the automotive OEMs took a licence and accepted royalties that are substantial compared to the value of the Telematics Control Unit (TCU) which, among other functions, provides cellular connectivity. From when Avanci was founded in 2016 until 2023 Avanci slowly increased its share of licensed units. Then, Avanci announced an increase to its 4G royalty rate by more than 30% from $15 to $20 per vehicle for licensees joining after September 2022, putting further pressure on automotive OEMs to sign up before then. Indeed, in 2022 Avanci signed various additional automotive OEMs.

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66 See https://fsr.eui.eu/wp-content/uploads/2021/05/SEP-Expert-Group-Report-CPI.pdf (accessed 21.08.2023).

67 *InterDigital Technology v Lenovo [2023] EWHC 539*, para 535.

68 See https://www.pymnts.com/cpi_posts/injunctions-facilitate-patent-licensing-deals-evidence-from-the-automotive-sector (accessed 30.07.2023) for details and references.

69 https://www.juve-patent.com/cases/conversant-and-daimler-end-connected-cars-dispute/ (accessed 30.07.2023).

70 https://www.juve-patent.com/people-and-business/volkswagen-agrees-on-full-avanci-licence/ (accessed 30.07.2023).

71 https://www.juve-patent.com/people-and-business/multiple-firms-prepare-for-wave-of-lawsuits-over-huawei-seps/ (accessed 30.07.2023).

72 https://www.juve-patent.com/people-and-business/ford-takes-avanci-licence-in-wake-of-munich-judgment/ (accessed 30.07.2023).

By August 2023, Avanci announced that it has already licensed more than 130m connected cars, which corresponds to about 68% of the 192m connected cars that are estimated to have been sold by end of 2023.[73]

70. We note that antitrust concerns over the SEP holders' insistence to license at the end device level and the refusal to license at the component level are still unresolved. The European Court of Justice was asked to decide on this issue in Nokia v Daimler but the case was settled before the court could reach a decision.[74] In *Apple v Optis* as well as in *InterDigital v Lenovo*, it was found that the ETSI FRAND obligation requires SEP holders to license to *any* third party irrespective of their position in the value chain.[75] Further, in order to meet the Soft Safe Harbour conditions (i.e. being exempt from a priori prohibition) the CMA's Horizontal Guidelines require SDOs to establish an IPR policy where participants license their IP to *any* member or third party, and thus to any player along the value chain.[76]

71. However, some SEP holders, including Nokia and Ericsson, still generally refuse to offer SEP licences at the component level,[77] and Avanci has not signed a single licence with a component supplier to date.

5. SMART ENERGY METERS

72. Smart energy meters are vital to the UK economy. The UK Department for Business, Energy, and Industrial Strategy (BEIS) estimated the benefits from smart energy meters for the UK economy at £19.5bn between 2013 and 2034.[78] Consumer benefits (39% of total benefits) include energy and time savings. Supplier benefits (42% of total benefits) include the avoidance of costly site visits. Moreover, smart meters allow for realizing benefits from shifting energy demand away from peak hours (7% of total benefits) as well as for avoiding costs of carbon emissions and realizing better air quality (10% of total benefits).

73. The UK Smart Meter Implementation Programme ("SMIP") governs the smart meter rollout. The goal of the SMIP is to provide consumers with real-time information and improve their control over their energy consumption.[79] The programme aims to roll-out approximately

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73 See https://www.juniperresearch.com/press/connected-vehicles-to-surpass-367-million-globally and https://www.avanci.com/2023/08/16/avanci-launches-5g-connected-vehicle-licensing-program/, accessed 24.08.2023.

74 https://www.juve-patent.com/cases/regional-court-dusseldorf-refers-nokia-vs-daimler-questions-to-cjeu/ (accessed on 30.07.2023).

75 *InterDigital v Lenovo* [2023] EWHC 539 (Pat), para 184 (iii).

Optis v Apple [2023] EWHC 1095 (Ch), para 387.

Optis v Apple [2021] EWHC 2564 (Pat), para 278.

76 CMA (2023), paras 9.22 and 9.33.

77 https://blogs.law.ox.ac.uk/business-law-blog/blog/2021/08/limiting-sep-licensing-end-product-manufacturers-exclusion-component (accessed 30.07.2023).

78 Department for Business, Energy & Industrial Strategy (2019).

79 https://smartenergycodecompany.co.uk/smip/. (accessed 31.07.2023)

53m smart electricity and gas meters to domestic properties and non-domestic sites in Great Britain. This will impact approximately 30m premises.

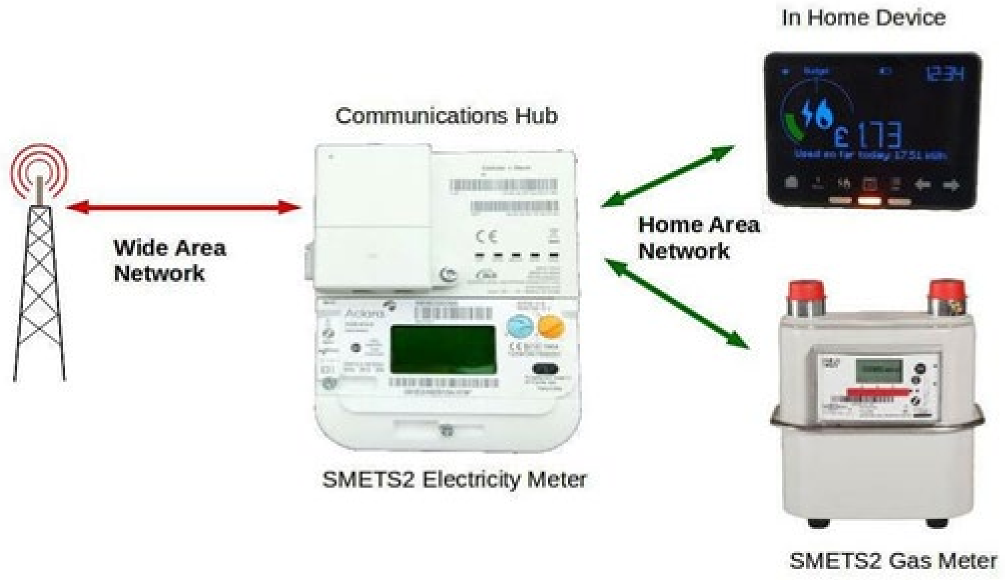
74. The SMIP has determined that communication between the premises and energy suppliers will rely on cellular connectivity for Central and South England (Section 5.1). The cellular connectivity is implemented through cellular communication hubs that sit on the smart energy meters. (Section 5.2). We estimate that the number of cellular communication hubs will increase to 23.7m devices by 2028 (Section 5.3). This requires 3.2m annual installations to account for all new installations as well as replacement of existing devices.

75. SEP holders can leverage the fact that the UK government has decided to rely on cellular connectivity for most of the UK premises (Section 5.4). SEP holders that refuse to license at the component level could target not only communication hub manufacturers, but also the Data Communication Company (DCC) that owns and operates the cellular communication hubs (or even UK energy suppliers). Irrespective of whether communications hub OEMs or the DCC will be targeted, licensing negotiation and potential litigation costs will be much higher than under component level licensing. Without intervention, SEP holders will enjoy leverage from hold-up which entails the risk that high, potentially non-FRAND royalty rates are extracted.

5.1. The UK smart energy metering system

76. The following figure illustrates the smart energy metering system in the UK. While the smart gas and energy meters in the UK usually are not equipped with cellular communication technology, the communication hubs, which typically sit on the smart energy meters, handle the communication with the smart meters and with the DCC's network.

Figure 7: The smart energy metering system in the UK



Source: https://www.smartme.co.uk/index.html (accessed 30.07.2023).

77. More precisely, the communications hub serves two main purposes:

- First, it establishes the Home Area Network ("HAN") and connects with the smart energy meters. For communication between the smart meters and the hub the ZigBee standard is used.[80] The communication hubs are procured and owned by the DCC.
- Second, the communication hub provides access to the Wide Area Network ("WAN"). The WAN is responsible for transmitting data collected by the smart meters to the energy suppliers. The communication standard of the WAN depends on the region. In Northern England and Scotland, the communication relies on Long-Range Radio communications, which is royalty free. The infrastructure is operated by Arqiva Limited. In Central and South England, communication takes place via Virgin Media O2's (formerly Telefónica) 2G/3G cellular network, which will be phased out by 2033.[81] This implies that existing communication hubs, which rely on 2G or 3G technology will have to be replaced with communication hubs that implement the 4G standard.[82] In the following, we will focus on the smart energy meter rollout in Central and South England because of the reliance on cellular communication technology, which is prone to SEP licensing issues.

78. There exist two types of communication hubs. The initial version, known as SMETS1 communication hubs, was the first to be introduced. However, these hubs suffer from limited interoperability between suppliers. This implies these communication hubs may become non-functional if consumers switch their supplier. To address this concern, the SEMTS2 communication hub was developed as an updated version of SMETS1. The installations of SMETS2 communication hubs began in 2018. This updated generation ensures that smart meters continue to operate seamlessly even after a change in suppliers. SMETS1 communication hubs will be replaced by SMETS2 hubs, which results in additional demand for SMETS2 hubs.

5.2. Smart meter value chain

79. The following figure illustrates the value chain for smart energy meters that are powered with cellular communication hubs. Cellular component manufacturers supply cellular modules or cellular chipsets for the communication hubs (Section 4.1.2).

80. We identified 9 manufacturers of smart energy meters that sell into the UK. These include the UK firm GWi as well as international firms with UK subsidiaries such as Aclara Meters UK, Itron Metering Solutions UK, Honeywell UK, and Landis + Gyr.

80 https://www.smartme.co.uk/smets-2.html (accessed 30.07.2023).

81 Ofcom (2023).

82 The DCC plans to finalize the regulatory criteria that must be satisfied to begin with the volume manufacturers of 4G communication hubs by the end of the first quarter in 2024. See the response of the Department for Energy Security and Net Zero from 21 July 2023 on a consultation regarding the DCC's implementation of 4G communication hubs that is currently available here: https://smartenergycodecompany.co.uk/ufaqs/ (accessed 26.07.2023)

81. We identified 7 manufacturers of cellular communication hubs.[83] These include Toshiba Europe, and WNC UK.[84] WNC UK, the UK subsidiary of WNC, and Toshiba Europe, the UK subsidiary of Toshiba, and others have obtained certification for several communication hubs under the Commercial Product Assurance ("CPA") scheme.[85]

82. The DCC operates under the Smart Meter Communications Licence, which is regulated by Ofgem. It is responsible for linking smart meters in homes and small businesses with energy suppliers, network operators and energy service companies.[86] Moreover, it oversees and manages the smart energy meter rollout in UK.

83. There are 48 UK energy suppliers that have binding smart meter installation targets from Ofgem in 2023.[87] If they do not meet their target with respect to the rollout of electricity and gas smart meters, they will have to pay penalties.

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83 We identify the relevant smart meter manufacturers and communication hub manufacturers from the central products list of the Smart Energy Code that contains the devices that the DCC can communicate with. The manufacturers are internationally operating firms which all have UK subsidiaries. See Smart Energy Code (https://smartenergycodecompany.co.uk/central-products-list/, accessed 26.07.2023)

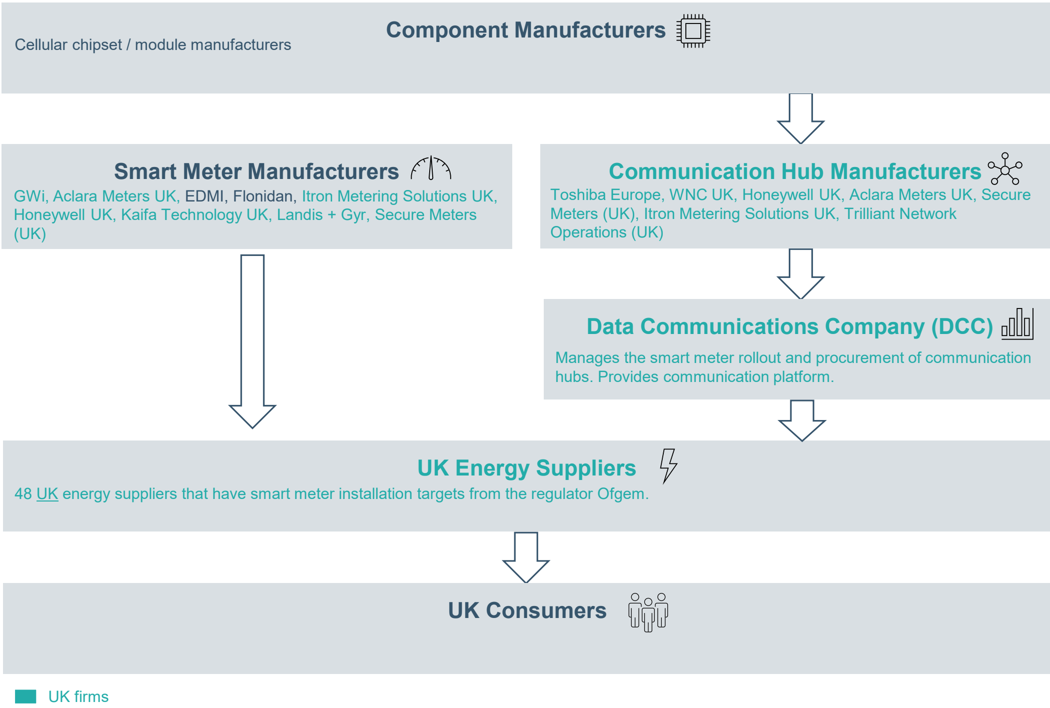
84 The central products list contains 8 manufacturers of communication hubs, but EDMI Ltd. only produces communications hubs that rely on the LRR technology that is deployed in Northern England and Scotland.

85 https://www.ncsc.gov.uk/organisation/wnc-uk-ltd, https://www.ncsc.gov.uk/organisation/toshiba-europe-limited/about-toshiba-europe-limited and https://www.ncsc.gov.uk/organisation/aclara-meters-uk-ltd/sgm1412-and-sgm1400b-smets2-meter-0 (accessed 27.07.2023).

86 https://www.ofgem.gov.uk/energy-policy-and-regulation/policy-and-regulatory-programmes/smart-meter-transition-and-data-communications-company-dcc (accessed 226.07.2023)

87 See the Ofgem 2023 Supplier Smart Meter Installation Targets (https://www.ofgem.gov.uk/energy-policy-and-regulation/policy-and-regulatory-programmes/smart-meter-transition-and-data-communications-company-dcc/smart-meter-transition-and-data-communications-company-dcc-supplier-smart-metering-installation-targets, accessed 26.07.2023).

Figure 8: Value chain for cellular smart energy meters and communication hubs



Source: CRA illustration.

5.3. Energy communication hub volume forecast for the UK

84. At the end of the first quarter of 2023, 32.4m smart meters have been installed in domestic and non-domestic premises in Great Britain.[88] Based on the population share in the area that relies on cellular communication hubs (corrected for differences in the rollout between the regions), we estimate that there are 21.4m (9m gas and 12.4m electricity) smart meters in Central and South England.[89]

85. Premises with both smart energy and gas meters typically share the same communication hub.[90] In order to arrive at a conservative estimate for the number of communication hubs, we assume that only the smart energy meters are equipped with a communication hub.[91] From this, we estimate that at the end of 2022 12m cellular communication hubs were installed.

86. The nationwide rollout of smart meters was equal to 55% at the end of 2022 and 57% at the end of March 2023. The UK Department for Energy Security and Net Zero also

88 Department for Energy Security and Net Zero (2023).

89 See the Office for National Statistics' "Estimates of the Population for the UK, England, Wales, Scotland and Northern Ireland" for the population shares (, accessed 26.07.2023).

90 Department for Business, Energy & Industrial Strategy (2019).

91 This implies the assumption that smart gas meters are only installed in premises in which there is already an electricity smart meter with a communication hub installed. If there are premises in which only a gas smart meter and a communication hub is installed the number of communication hubs is larger than our estimate. Note that the BEIS cost-benefit analysis of SMIP estimates that in the case of SMETS1 smart meters a premise might need more than one communication hub (see fn. 78).

publishes annually regional information on the rollout of domestic smart energy meters by local authorities. This allows us to compare the progress between the region with cellular communication hubs and the region with LRR (i.e., non-cellular) communication hubs. We find that the population-weighted rollout based on this source is equal to 51% in the cellular region and equal to 55% in the LRR region. For our estimation, we therefore assume that the rollout of smart meters was equal to 51% in the cellular region at the end of 2022.

87. The share of the population that lives in the area that relies on cellular communication hubs is equal to 68% (44.1m of 65.1m). We adjust this population share based on the difference in rollout progress. We therefore assume that 66% of all communication hubs were installed in the cellular area at the end of 2022.

88. The UK Department for Energy Security and Net Zero has proposed reaching 80% of the homes (and 73% of small businesses) with smart energy meters by 2025.[92] This implies that the rollout must continue at a rate of approximately 8.3 percentage points each year in the cellular area.

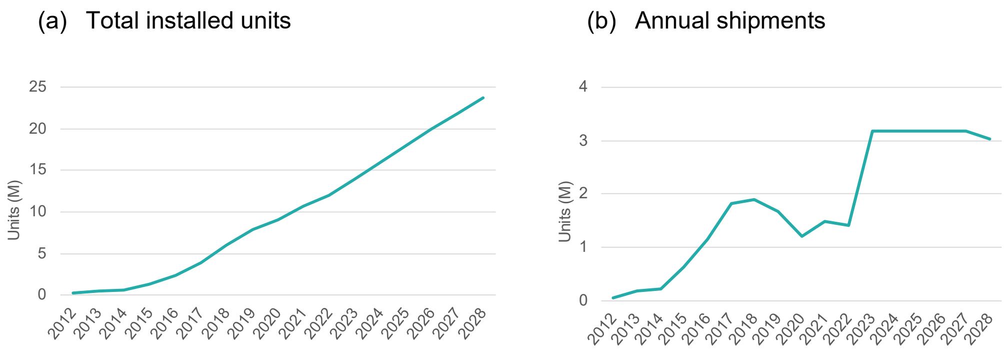
89. We assume that the rate of the rollout meets the current targets. In this case, the number of smart energy meters and hence cellular communication hubs increases to 18m by 2025. If the rollout continues at the same rate until the share of smart meters is equal to 100%, we estimate that there will be 23.7m communication hubs by the end of 2028.

90. The left panel of Figure 9 below summarizes the historic and forecasted stock of cellular smart energy meters and communication hubs from 2012 until 2028.

91. Besides the stock of cellular communication hubs, we also consider the annual installations of cellular communication hubs. These are depicted in the right panel of Figure 9. The Department for Energy Security and Net Zero publishes historic information on yearly installations of communication hubs. In order to achieve the targeted levels of rollout, the stock of installed communication hubs must increase by around 2m each year. The existing stock of SMETS1 communication hubs must be replaced over time and in 2024 a new generation of 4G communication hubs will become available. In order to capture the replacement of existing 2G communication hubs with the updated 4G version, we assume that from 2023 onwards, 10% of the 2022 stock of cellular communication hubs will be replaced each year, which requires an additional 1.2m communication hubs annually. In total, we therefore expect approximately 3.2m annual installations of cellular communication hubs from 2023 until the rollout target of 100% is reached.

92 National Audit Office (2023).

Figure 9: Historic and forecasted installed units and annual shipments of cellular communication hubs



Source: CRA based on National Audit Office and Department for Energy Security and Net Zero data.

5.4. SEP licensing issues in the UK smart energy meter sector

92. In this section we examine how the SEP licensing issues as discussed in Section 4 for the IoT in general will impact the UK smart energy meter sector.

93. **Level of SEP licensing**. SEP holders that refuse to license at the component level will seek licences later in the value chain. Two different levels are particularly relevant:[93]

- Communication hub manufacturers: SEP holders could pursue a similar approach as for the smartphone vertical and request the end device vendors take licences. From an SEP holder perspective, whether it will be attractive to target a communication hub manufacturer critically depends on the potential licensee's volume of products implementing cellular standards. Important aspects in this regard are whether a manufacturer also sells (i) communication hubs for countries other than the UK or (ii) other products implementing cellular standards. In relation to the first point, we understand that SMETS1 and SMETS2 communication hubs are produced specifically for the UK. In relation to the second point, it is well possible that communication hub providers also manufacture other products implementing cellular standards. Considering the volume of annual communication hub installations is in the order of millions, the main communication hub manufacturers (including their UK subsidiaries WNC UK Ltd. And Toshiba Europe Ltd.) will be attractive targets for SEP holders.

93 We cannot exclude that SEP holders will also approach UK energy suppliers to claim royalty payments. The energy suppliers are responsible for fitting the smart meters as well the communication hubs and they rely on the communication hubs for billing.

- DCC: Alternatively, SEP holders could target the DCC directly, as it arguably infringes cellular SEPs by using the communication hubs. If the DCC does not agree to the requested royalty rates, SEP holders could bring an infringement action against the DCC and seek an injunction with a view to precluding the DCC from operating the communication hubs. Clearly, the SEP holders' hold-up leverage against the DCC would be enormous, considering the sunk installation costs of the communication hubs. The lock-in is exacerbated by the regulatory framework of SMIP which prescribes the cellular connectivity of the communication hubs. Importantly, SEP holders would not only have leverage over communication hubs procured by the DCC in the future, but also over communication hubs installed in the past. The volume of installed communication hubs, which will grow from 12m units to 23.7m by the end of 2028, makes the DCC a very attractive target.

94. **Implications on SEP licensing transaction costs**. In both scenarios in which licensing does not take place at the component level, SEP licensing would give rise to inefficiently high transaction costs. Communication hub manufacturers or the DCC would have to incur negotiation and in some cases litigation transaction costs to secure SEP licences, instead of procuring licensed cellular components and benefiting from efficient licensing at the component level. Cellular component suppliers typically conclude SEP licences for multiple use cases, which implies that the transaction costs for concluding a licence are spread across tens or hundreds of customers over several verticals. These efficiencies are lost if licensing for smart energy meters takes place at the end device level. In Section 4.2.2, we show that transaction cost savings from component level licensing in the UK can amount to as much as 99% compared to end device licensing.

95. **Risk of non-FRAND royalty rates**. SEP licensing at the end device level also raises a risk of potential licensees being pressured into accepting non-FRAND licensing terms, for the reasons laid out in Section 4.3 above. The DCC most likely will lack licensing experience and could hardly afford distractions from SEP litigation. This is also driven by the fact that the DCC is a monopoly that is regulated under the DCC's Operational Performance Regime that ties the profitability of the DCC to meeting certain implementation milestones. In case there are delays due to inefficient SEP licensing, the DCC is at risk of missing such milestones.[94] Moreover, we understand that the cost for communication hubs is fully passed on to energy suppliers.[95] Therefore, it may well be rational for the DCC to accept non-FRAND rates which would then also be passed on to energy suppliers and ultimately to UK consumers.

96. The findings and court-determined royalty rates in the recent *Optis v Apple* and *InterDigital v Lenovo* cases, demonstrate that SEP holders are seeking inflated, non-FRAND royalties. There is a real risk that SEP holders will continue to demand, and secure, non-FRAND rates, especially from implementers that either lack the financial incentive or cannot afford to litigate (Section 4.3). Inflated SEP royalty rates would result in a material increase in the cost of the smart meter rollout in the UK, as is demonstrated in the following example.

97. In *Optis v Apple*, the court disapproved the royalty demanded by Optis, which was based on a percentage of the end device price, and instead determined a FRAND royalty that

94 https://www.ofgem.gov.uk/publications/dcc-operational-performance-regime-principles-and-objectives (accessed 27.07.2023).

95 Data Communications Company (2022).

amounted to less than 2% of the total sum sought by Optis.[96] However, by taking the royalty rate of 0.192% of the device price (capped at $1.15 per unit) Optis sought in negotiations and scaling this against Optis' patent share of 0.61%, it can be seen that Optis' licensing approach implies an aggregate royalty burden of 31.5% of the device price.[97] The 4G royalty rates announced by Qualcomm or Ericsson in the past imply an aggregate royalty burden of a similar order of magnitude, indicating it is not uncommon for licensors to seek such rates.[98]

98. A standard communication hub is estimated to cost £28 per device.[99] The BEIS expects that this type of communication hub is suitable in 70% of premises.[100] For the remaining premises, dual-band communication hubs are required, with additional cost per device amounting to £23. Applying the ARB of 31.5% implied by Optis' demands in negotiations would raise the cost of a 4G single-band communication hub by £8.80 to £36.80 and of a dual-band communication hub by £16.10 to £67.10. For the 23.7m cellular communication hubs that will be rolled-out by 2028 this would result in SEP royalties of £260m, when the decision in Optis v Apple suggests, the true FRAND royalty that should be paid could be less than 2% of this figure (i.e., no more than £5.2m). These excess royalties could result in the hubs costing nearly £255m more than they ought.[101]

99. Additionally, there are other ways in which SEP holders could seek to inappropriately leverage their strong market power to extract even higher royalties. For instance, they could seek to extract even higher royalties based on the argument that cellular connectivity is a critical feature of communication hubs. Alternatively, SEP holders might argue that the royalty base should also include the value of the smart energy meters connected by the communication hub. While such inflated demands would most likely be found to be non-

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96 *Optis v Apple* [2023] EWHC 1095 (Ch), paras. 342 and 494. Calculated as $5.13m / $266m = 1.9%.
The amount awarded does not cover the entire Optis SEP portfolio. Due to heavy redactions, we cannot deduce from the judgment whether Optis' December 2017 offer included patents that were not required, which would be a manifestation of inflated royalty claims. The amount awarded for the entire Optis SEP portfolio of $8.235m corresponds to 3.1% of $266 million. The findings below would be similar if it were assumed that the courts would award 3.1% of the royalties claimed.
Similarly, the 2023 FRAND judgement in *InterDigital v Lenovo* also revealed a material discrepancy between the rate requested by the patentee and the FRAND rate awarded by the court. In this case, the court awarded FRAND per unit rate of $0.175 amounted to merely 35% of the $0.498 requested by InterDigital. *InterDigital v Lenovo* [2023] EWHC 539, paras. 23 and 807.

97 *Optis v Apple* [2023] EWHC 1095 (Ch) (29 May 2023), paras. 353 and 460.

98 Ericsson announced an LTE royalty rate of 1.5% for handsets in 2009. See https://web.archive.org/web/20091114210803/http:/www.ericsson.com/technology/licensing_programs/ (accessed 31.08.2023). Its 4G SEP share according to Tech + IP Advisor (2022) is 4.49%, implying an ARB of 33.4%. Qualcomm announced a 4G royalty rate of 3.25% per device in 2009. See https://www.qualcomm.com/content/dam/qcomm-martech/dm-assets/documents/lte-wimax-patent-licensing-statement_1.pdf (accessed 31.08.2023). Its 4G SEP share according to Tech + IP Advisor (2022) is 8.80%, implying an ARB of 36.9%.

99 Cost for a communication hub with single-band 2.4 GHz HAN solution according to Department for Business, Energy & Industrial Strategy (2019).

100 Department for Business, Energy & Industrial Strategy (2019), p. 24.

101 Shortly after the litigation had started, Optis increased the requested royalties to 0.410% of the Net Selling Price ("NSP") for 4G devices sold in "Major Markets" and 0.161% of the NSP sold in "Other Markets" or China. A royalty rate of 0.41% would imply an ARB of 67.2% and increase the excess royalties to more than £550m.

FRAND in court, start-ups and SMEs in the IoT sector may lack the resources to litigate against excessive royalty demands in the first place.

6. SMART WATER METERS

100. The UK has ambitious targets for reducing water demand in order to secure the nation's future public water supply. The UK "Plan for Water" aims to bring down per capita water consumption to 122 litres per person per day by 2037-38.[102] To accomplish this objective, enhancing water efficiency and reducing leakage are crucial, with smart water meters playing a pivotal role.

101. The implementation of smart meters contributes to improved water efficiency by providing consumers with daily and sub-daily usage data, empowering them to better understand their water consumption and find ways to save water. Furthermore, more frequent information on water usage helps water suppliers identify and address leaks promptly. An additional advantage of smart water meters is that they enable water suppliers to reduce operational costs by eliminating the need to send workers to manually read the water meters.

102. The UK Plan for Water actively encourages water companies to accelerate the installation of smart meters for both households and non-household customers. This initiative aligns with the UK Environment Agency's recommendations, which urge water suppliers to shift away from traditional meters and adopt smart water meters instead.[103] In line with this target, the UK Water Services Regulation Authority Ofwat announced in April 2023 support for several water suppliers such as Anglian Waters and Severn Trent Water in rolling out 462,000 smart water meters.[104]

103. As of today, the industry for smart water meters relies on a variety of proprietary and standardised communications technologies.[105] Automated meter reading (AMR) solutions which enable wireless walk- or drive-by meter reading operations often rely on the Wireless M-Bus standard. Advanced metering infrastructure (AMI) solutions rely on wide area connectivity (including NB-IoT, LoRaWAN, or Wize) and enable high-frequency readings of detailed meter data while also allowing for direct two-way communications with the utility back office. While currently the installed base of NB-IoT powered smart water meters is limited, their deployment may increase rapidly in the coming years. Because of its extremely low power consumption, NB-IoT is well suited for smart water meters. A further benefit is that mobile network operators can save on infrastructure costs by leveraging their existing cellular infrastructure for NB-IoT. In 2021, telecommunications provider Vodafone UK announced the establishment of a new IoT management platform for the UK water

102 Department for Environment Food and Rural Affairs (2023).

103 UK Environment Agency (2023).

104 https://www.smart-energy.com/industry-sectors/smart-water/uk-water-authority-accelerates-smart-water-meters-deployment/ (accessed 25.07.2023)

105 Berg Insights (2022), "Smart Metering in Europe and North America" (https://www.berginsight.com/smart-water-metering-in-europe-and-north-america (accessed 25.07.2023).

industry.[106] The platform will use Vodafone's NB-IoT network, which has connectivity to 98% of the entire UK geography. This platform will expand the choice of water companies and will allow them to integrate a wide range of devices. Similarly, British Telecoms started the rollout of a nationwide IoT network in 2023. They will offer a range of communication technologies such as NB-IoT, LTE-M, and LTE-Cat-1.

104. While the smart water meter industry is still in its early stages, SEP licensing issues related to cellular communication technologies could potentially hinder its development and result in suboptimal technology adoption. Addressing these frictions is critical to ensure a smooth and effective transition to smart water metering.

6.1. Cellular smart water meter value chain

105. The figure below illustrates the value chain for *cellular* smart water meters. Cellular components are an input for manufacturers of smart water meters such as Kamstrup, Itron, and Landis+Gyr. In total, we have identified 10 manufacturers of cellular smart water meters.[107] For example, the manufacturer Kamstrup has partnered with Vodafone in Europe since 2015 to establish cellular IoT solutions for smart energy and water meters.[108] Typically, smart water meters have built-in cellular communication technology and some manufacturers also offer cellular gateways that collect data from several smart water meters and transmits them to the water suppliers via the cellular network. There are also third-party providers that offer (cellular) modems that make traditional water meters smart.[109]

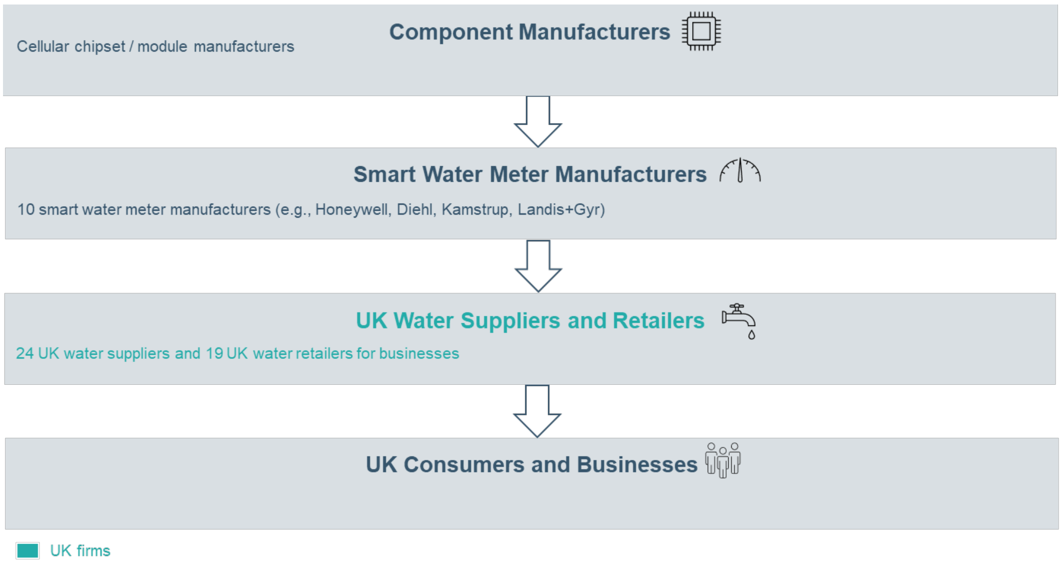
106 https://www.vodafone.co.uk/newscentre/press-release/unique-iot-to-accelerate-change-in-uk-water-industry/ (accessed 29.07.2023).

107 Arad, Badger Meter, Diehl, Honeywell/Elster, Itron, Kamstrup, Landis+Gyr, Metering Technology Solution, Wasion, and Waterfall. Compiled from three different sources:
(i) https://mosl.co.uk/document/market-improvement/strategic-metering-programme/key-documents-smr/guidance-documents/4757-metering-technology-and-supplier-overview/file (accessed 30.07.2023)
(ii) https://www.vantagemarketresearch.com/industry-report/smart-water-metering-market-1185 (accessed 30.07.2023)
(iii) https://www.blackridgeresearch.com/blog/list-of-global-top-smart-electric-electricity-gas-water-meter-companies-manufacturers-makers-suppliers-in-the-world. (accessed 30.07.2023)

108 https://www.smart-energy.com/regional-news/europe-uk/kamstrup-and-vodafone-launch-cellular-internet-of-things-solution/ (accessed 29.07.2023).

109 https://www.haustec.de/gebaeudehuelle/gebaeudeautomation/elvaco-bringt-nb-iot-modul-cmi6140-fuer-kamstrup-zaehler-auf-den (accessed 29.07.2023) and https://m2mserver.com/en/product-category/water-metering-devices/ (accessed 29.07.2023).

Figure 10: Value chain for cellular smart water meters



Source: CRA illustration.

106. There are 24 regional water suppliers in charge of the smart water meter infrastructure in the UK and the provision of water services to households.[110] The largest water suppliers by revenue are Thames Water, Severn Trent Water, and United Utilities.[111] Additionally, there are 19 water retailers such as Waterscan and Cambrian that can serve UK businesses.[112] The UK government encourages and incentivises the rollout of smart meters in order to achieve the goal of a resilient water supply set out in the UK Plan for Water. Several water suppliers have started with the rollout of smart water meters. Notably, South East Water (partnering with Vodafone) and Yorkshire Water (partnering with British Telecom) deploy cellular smart water meters.[113]

6.2. Smart water meter rollout

107. According to a report published in 2023 by the UK Environment Agency, 60% of households are metered and 14% of households have smart meters.[114] Many water suppliers plan a rollout of smart water meters. Current plans project around 40% smart metering of households by 2030, 63% by 2040, and 65% by 2050. Moreover, the UK Environment Agency estimates that there will be a total non-household smart metering penetration of 35% by 2050.

110 https://www.ofwat.gov.uk/households/your-water-company/contact-companies/ (accessed 31.07.2023).

111 https://www.statista.com/statistics/1179995/leading-water-and-sewer-utilities-companies-in-the-united-kingdom/ (accessed 30.07.2023).

112 https://www.open-water.org.uk/for-customers/find-a-retailer/suppliers/english-water-and-wastewater-retailers/ (accessed 31.07.2023).

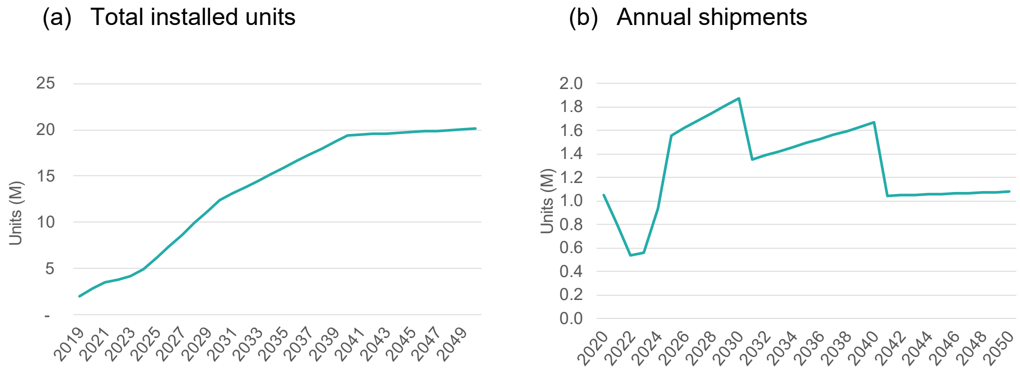
113 https://www.southeastwater.co.uk/help/water-supply/smarter-water-networks-trial/ and https://www.yorkshirewater.com/news-media/news-articles/2020/hadfield-nb-iot-installation/ (both listed by Berg Insight 300 Emerging IoT Projects Worldwide, accessed 29.07.2023).

114 UK Environment Agency (2023), Appendix A.

108. Berg Insight states that while the share of cellular smart water meters is currently between 2% - 5% in Europe and America, the growth of cellular smart water meters will be massive in the future.[115] As the exact share of future cellular connections is uncertain, we provide estimates of all smart water meters (cellular and non-cellular) below. As shown in the left panel of Figure 11 we estimate that there will be 20m smart water meters in the UK by 2050.[116] The adoption of *cellular* smart water meters will depend on whether licensing frictions hamper the development of this technology or not.

109. To estimate yearly installations of smart meters between 2023 and 2050, we assume that each year 5% of the existing stock of smart meters must be replaced. Yearly installations are therefore expected to fluctuate around 1.5m until at least 2040 (right panel of Figure 11). From 2040 to 2050 yearly installations are expected to decline slightly to around 1m installations per year as the installations will focus more on replacing existing stock instead of rolling out new smart meters.

Figure 11: Historic and forecasted installed units and annual shipments of smart water meters



Source: CRA calculations based on UK Environment Agency data.

6.3. SEP licensing issues in the UK smart water meter sector

110. Even though the government encourages and incentivises the rollout of smart water meters, compared to smart energy meters (see Section 5) progress has been limited, and the rollout is still in its early stages. Given the urgency with which the UK must act to meet the "Plan for Water", it is clear that further delays would be detrimental. Importantly, licensing frictions can stifle the growth of the smart water meter industry and threaten the important benefits associated with this technology.

111. **Level of SEP licensing**. The main targets for SEP holders that refuse to license at the component level will be the smart water meter manufacturers as well as UK water suppliers:

115 https://www.berginsight.com/smart-water-metering-in-europe-and-north-america (accessed 25.07.2023).

116 For our calculation, we rely on the figures of 28.2m UK households and 5.5m private sector businesses recorded in the year 2022. We assume that these estimates are constant over time. (https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families/bulletins/familiesandhouseholds/2022 and https://www.money.co.uk/business/business-statistics, accessed 25.07.2023).

- Smart water meter manufacturers are international firms that sell their products in the UK and in part have UK subsidiaries. From an SEP holder perspective, whether it would be attractive to target a smart water meter manufacturer will depend on the potential licensee's volume of products implementing cellular standards. Important aspects in this regard are whether a manufacturer also sells (i) smart water meters to countries other than the UK or (ii) other products implementing cellular standards.
- UK water suppliers are publicly regulated and regionally operating firms. UK water suppliers will own and operate the smart water meters. If no licence agreement is reached, SEP holders could therefore bring infringement actions against UK water suppliers and seek injunctions with a view to precluding them from operating the smart meters. The SEP holders' hold-up leverage against UK water suppliers would be enormous, considering the sunk installation costs of the smart water meters. For the reasons discussed in Section 4.3, UK water suppliers are likely not in a position to negotiate truly fair and reasonable royalty rates with SEP holders. Moreover, they likely lack the necessary resources and regulatory mandate for costly and lengthy litigations in case of unsuccessful negotiations.

112. **Connectivity technology choice.** Licensing frictions can lead to suboptimal technology adoption. With the advent of NB-IoT, cellular communication technologies may well be the most efficient technologies for smart water meters in the UK. The reliable existing network infrastructure and high coverage make this an attractive choice that should allow for quick deployment. Moreover, an important efficiency could materialize if the existing Wide Area Network of the smart energy metering system could also be tapped for smart water meters, as the smart energy metering system already relies on cellular communication in Central and South England. Note that exactly this sharing of infrastructure already happens on the LRR network of Arqiva.[117] The risk of SEP licensing issues may however result in the adoption of alternative communication technologies that may not promise the same efficiencies with existing infrastructure.

7. TRANSPORT & LOGISTICS TELEMATICS

113. Transport & logistics telematics devices have a wide range of use cases for UK business customers, such as increasing productivity through tracking and route planning, improving driver safety, optimizing fleets, aiding in the achievement of sustainability goals, or facilitating compliance processes (Section 7.1).

114. The UK transport telematics industry has established itself as an innovation hub, with numerous UK companies developing innovative software and hardware solutions for business customers in the transport & logistics sector (Section 7.2).

115. Unit sales in the industry are already large today and are expected to increase significantly in the coming years. Using a very conservative methodology, we estimate that UK companies had provided approximately 49m active connections by the end of 2021, which is expected to increase to more than 86m by the end of 2030. Annual unit sales are projected to increase from 7.4m units in 2021 to 9.8m units in 2030 (Section 7.3). High

117 https://utilityweek.co.uk/smartening-up-is-uk-water-metering-ready-for-a-smart-revolution/ (accessed 29.07.2023).

cellular volume sales can be expected to attract interest from SEP holders seeking royalties in the coming years.

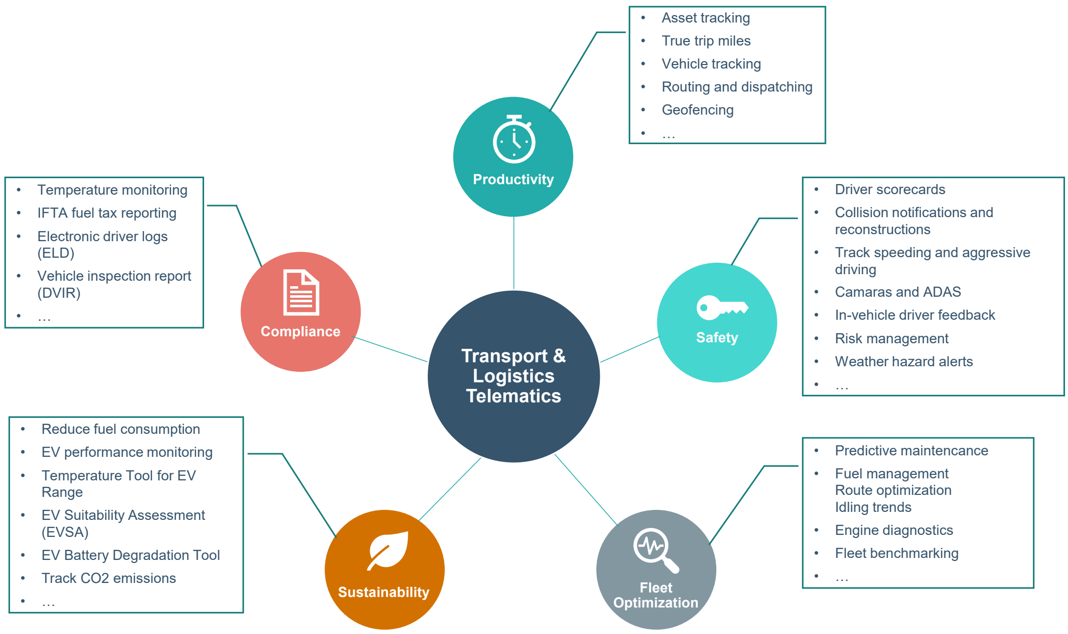
116. We identify a high risk for SEP licensing issues in the UK telematics sector (Section 7.4). *First*, Avanci's Aftermarket licensing pool was established in early 2023 and is targeting transport & logistics devices and, given Avanci's licensing behaviour in the automotive industry, will likely target manufacturers at the end device level. *Second*, we see a high risk of litigation in the UK telematics sector as it can be expected that the Avanci Aftermarket pool members will adopt a similarly aggressive litigation strategy as in its Vehicle 4G pool. *Third*, we estimate that the average transaction cost from end device level licensing accruing to a UK company may exceed £500k per cellular standard – posing a serious threat to the commercial viability of some start-ups and SMEs. *Fourth*, UK innovators in the transport & logistics telematics industry may face an excessive royalty burden once the licensing landscape has fully materialised. Based on the current royalties requested by the Avanci Aftermarket pool, we estimate that the aggregate royalty burden may be as high as 21% of the average telematics device price – clearly exceeding FRAND benchmarks for cellular standards determined by courts in the past.

7.1. The transport & logistics telematics industry

117. Telematics more generally refers to the integration of telecommunications and information technology to collect, transmit, and receive data from remote objects or assets. The cellular IoT telematics vertical covers a variety of end-uses, wherever remote tracking, diagnostics or management of assets is required. This includes but is not limited to the insurance, healthcare, media & entertainment, and the transport & logistics sectors. We focus in the following on the transport & logistics sector as a sub-market of the wider IoT telematics vertical.

118. Figure 12 below illustrates the various use cases for telematics devices in the transport and logistics sector. First, transport and logistics telematics can be used to increase *productivity* by enabling the tracking of vehicles and assets or by improving routing or dispatching by supporting geofencing, a practice widely used in the delivery business. Second, the devices can increase *safety* in the transport & logistics business through remote tracking of speeding or improper driving, providing live collision notifications and alerts for weather and road hazards. Third, telematics devices can be used to improve the *sustainability* of a business by tracking CO2 emissions, providing diagnostics to lower fuel consumption, and through performance monitoring of electric vehicles to improve energy usage. Fourth, IoT telematics devices in the transport and logistics sector can be used to improve on *compliance* requirements, e.g., related to fuel tax reporting, driver logs or vehicle inspection reports.

Figure 12: Business use cases for telematics applications



Source: CRA based on Geotab: https://www.geotab.com/blog/what-is-telematics/ (accessed 26.07.2023).

119. Transport and logistics telematics devices can be classified into different product categories. These include, but are not limited to: (see Table 8 below for illustrations):

- **Diagnostics devices**. Telematic diagnostic devices can allow for the remote monitoring of information including speed, motion and vehicle usage, typically by connecting to the On-Board Diagnostics II (OBD-II) or CAN-BUS port that is required on all vehicles located near the steering wheel or dashboard. The OBD-II port collects data from many sensors and monitoring devices installed in a vehicle. Alternatively, diagnostic devices can also be hardwired into the vehicle, e.g. using CAN-BUS clips. Usually, a SIM card and modem in the device work together to transmit the recorded data to a server or a database over a cellular network.[118] Diagnostic devices typically also come with a tracker functionality.

- **Vehicle / asset trackers.** Cellular vehicle & asset tracking systems use a combination of GPS and cellular networks to provide real-time location and motion data.[119] Tracker devices typically utilize a combination of embedded sensors and a modem for communication and do not rely on a specific connection (e.g. via OBD-II port) with the asset / vehicle for information gathering and transmission.

- **Telematics camera.** Telematics cameras are connected through cellular networks, uploading video data – often in real time. Cameras are usually mounted on the dashboard or windscreen and can be front / rear - or dual facing, recording either only the street or also the driver. Most cameras are purchased for evidence in insurance claims.[120]

118 https://www.metromile.com/blog/5-types-of-telematics-devices/ (accessed 26.07.2023).

119 https://ubisense.com/guide-asset-tracking-technologies/#anchor8 (accessed 26.07.2023).

120 https://www.icompario.com/en-gb/telematics/which-dash-cam-should-i-buy/ (accessed 26.07.2023).

- **Communication devices.** On-board telecommunication devices usually come in the form of ruggedised tablets or smartphones and are equipped with tailored software to enable instant communication with the driver, navigation and rout-planning, task tracking and allocation, etc.[121] The devices are usually equipped with a SIM card and are connected to cellular networks.

Table 8: Telematics devices

Diagnostics devices **[1]**	**Vehicle / Asset Trackers** **[2]**	**Telematics camera** **[3]**	**Communication device** **[4]**
			

Sources: [1] https://www.masternaut.com/all-solutions/telematics-devices/m210-obd-device/.
[2] https://hanhaa.com/parcelive/.
[3] https://surecam.com/blog/factors-to-consider-when-investing-in-dual-facing-dash-cameras.
[4] https://www.fleetequipmentmag.com/detroit-diesel-corp-launches-on-board-tablet-for-daimler-detroit-connect/ (all accessed 26.07.2023).

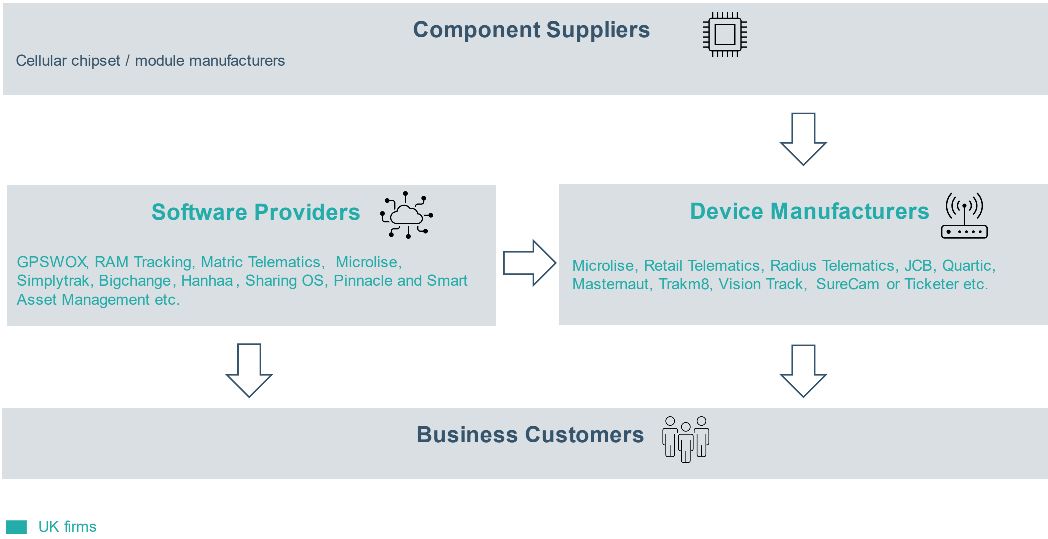
7.2. Telematics value chain

120. The transport & logistics telematics value chain is depicted in Figure 13 below. Device manufacturers procure cellular chipsets / modules from international component suppliers. We have identified numerous UK manufacturers of telematics devices which we discuss in detail in Section 7.3 below. Examples are Microlise, Retail Telematics, Radius Telematics, JCB, Quartic, Masternaut, Trakm8, Vision Track, SureCam and Ticketer. UK device manufacturers cover the full range of transport & logistics devices, from trackers and diagnostic devices to telematics cameras and on-board communication devices.

121. Device manufacturers either sell the "naked" hardware device to their business customers or provide integrated solutions, either using their own software / platforms or utilising third party software. There are various UK based software providers that supply either the device manufacturers or the end customer directly with innovative solutions for asset / fleet tracking, diagnostics, video telematics, driver communication, etc. Examples are GPSWOX, RAM Tracking, Matric Telematics, Microlise, Simplytrak, Bigchange, Hanhaa, Sharing OS, Pinnacle, and Smart Asset Management.

121 https://www.microlise.com/fleet-management/fleet-telematics/driver-communications/ (accessed 26.07.2023).

Figure 13: Telematics value chain



Source: CRA illustration.

7.3. Importance for the UK economy

122. Several UK companies are developing a range of innovative telematics solutions for UK business customers. We will provide a brief profile for a selection of these companies in the following. We then show that cellular unit sales by UK companies are already significant today – and are expected to grow substantially in the future.

UK telematics solution providers

123. Some of the largest and fastest growing telematics solution providers are headquartered in the UK. According to industry analyst Berg Insight, of the 500 largest cellular IoT projects worldwide in 2021, 20 are developed by UK companies (all separate companies) that provide transportation and logistics telematics solutions.[122]

124. UK telematics providers are therefore an integral part of the global cellular IoT market and a key element of the country's digital transformation process. In the following, we present a selection of UK companies developing innovative telematics devices for the transport & logistics sector:

122 Berg Insight (2021).

- **Microlise** provides integrated telematics solutions for the transport & logistics sector; utilizing performance, safety, sustainability and compliance information. The company is headquartered in Eastwood, England and had total 2022 revenue of £63.2m.[123] Its core business is to provide a platform for transportation and journey management (TMS), fleet performance, safety and compliance, as well as hardware solutions such as ruggedised devices to manage driver communication, tracking units and camera solutions.[124] Berg Insight estimates that by 2021 the company had sold around ~500k active cellular IoT connections. This figure is forecasted to increase by 76% to more than 880k connections by the end of 2025.
- **Radius Telematics** develops vehicle diagnostics, tracking, and telematics camera solutions. The company labels itself as "one of the fastest growing telematics businesses in the world".[125] The company is based in Crewe, Cheshire, with more than 20 offices across the UK and a turnover of around £3bn, making it one of the largest players in the industry. In 2021, the company purchased Chinese tracker manufacturer CanTrack,[126] adding another established brand to its own telematics portfolio. Radius Telematics claims to have installed more than 600k live tracking units throughout Europe, Asia, North America, Australia and Africa.[127] Berg Insight (2021) estimates that the total number of active cellular units provided by Radius Telematics will increase to over 900k by the end of 2025.
- **JCB** is a well-known British success story in the construction and agriculture sector. Headquartered in Rochester, England, the company has a turnover of more than £3bn[128] and employs more than 5.5k workers in its UK companies alone. The JCB LiveLink[129] is a telematics device utilising the Microlise platform, specifically tailored to construction and agricultural machines. The device offers remote tracking, diagnostic and maintenance alerts to ensure machines remain operational onsite. Berg Insight estimates the number of active LiveLink units by the end of 2025 will be around 590k.
- **Quartix** is a manufacturer of tracking and diagnostic devices[130] based in Newton, Warwickshire. It runs a fast-growing telematics business supplying the transport and logistics sector, reaching around 400 new fleet customers every month.[131] Berg Insight estimates the number of active cellular units provided by Quartix will increase by more than 130% between 2021 and 2025 to more than 400k.

123 Microlise (2022).

124 Microlise (2022).

125 https://www.radiustelematics.com/ (accessed 27.07.2023).

126 https://cantrack.com/ (accessed 27.07.2023).

127 https://www.radiustelematics.com/ (accessed 27.07.2023).

128 https://www.jcb.com/en-gb/news/2021/09/jcb-remains-profitable-in-2020-despite-covid-19-turbulence (accessed 27.07.2023).

129 https://www.jcb.com/en-us/parts-and-services/livelink (accessed 27.07.2023).

130 https://www.quartix.com/installation-options/#Self-install-vehicle-trackers:-The-flexible-option (accessed 27.07.2023).

131 https://www.quartix.com/en-gb/ (accessed 27.07.2023).

- **VisionTrack**[132] and **SureCam**[133] are both UK based suppliers of video telematics devices and software solutions. The cameras are typically also used as tracking devices, can record video footage, share live-streams, and provide an instant alert system.[134] Berg Insight estimates that both companies combined will increase the number of installed cellular units between 2021 and 2025 by more than 110% to more than 250k active IoT devices.

125. The companies profiled in this section represent only a small sample of what is a well-established and fast-growing innovation hub of UK IoT telematics device manufacturers. This is confirmed when looking at the historical and future telematics sales volumes of UK companies below.

Historic and future telematics growth

126. In the following, we provide estimates for the total installed volumes and yearly unit sales of transport & logistics telematics solutions developed by UK firms. We derive the estimates based on data provided by Berg Insight (2021) on active cellular IoT connections covered in two reports: “The 500 Largest Cellular IoT Projects Worldwide” and “300 Emerging Cellular IoT Projects Worldwide”.

127. The Berg Insight data covers active cellular IoT connections by company as of 2020Q4 and includes forecasts up to and including 2025Q4. We filter the data for companies with headquarters in the UK only and select projects related to two verticals: “Aftermarket Automotive” and “Transport & Logistics”. The resulting selection is then confirmed to only contain transport & logistics telematics projects. This leaves us with 26 UK companies and 27 different projects, covering close to 11.4m active units in 2020Q4.

128. The Berg Insight data covers only around 24.4% of all global IoT connections (see Section 4.1.3). We thus scale the data selected in the 2020Q4 – 2025Q4 period by this factor to approximate the total market, assuming that Berg Insight’s coverage of the global cellular IoT market applies analogously to UK transport & logistics projects. This leaves us with around 46.5m active units in 2020Q4. Scaling up the number of UK firms by the share of IoT connections covered by Berg Insight, we arrive at an estimate of 106 UK transport & logistics companies.

129. The number of installed units post 2025 is assumed to grow with the forecasted 2020-2025 compound annual growth rate of 6.3%.[135]

130. Having estimated the stock of active units in each year, we then calculate the yearly sales of UK companies as the yearly difference in this stock. In the yearly sales figures, we

132 https://www.visiontrack.com/ (accessed 27.07.2023).

133 https://surecam.com/ (accessed 27.07.2023).

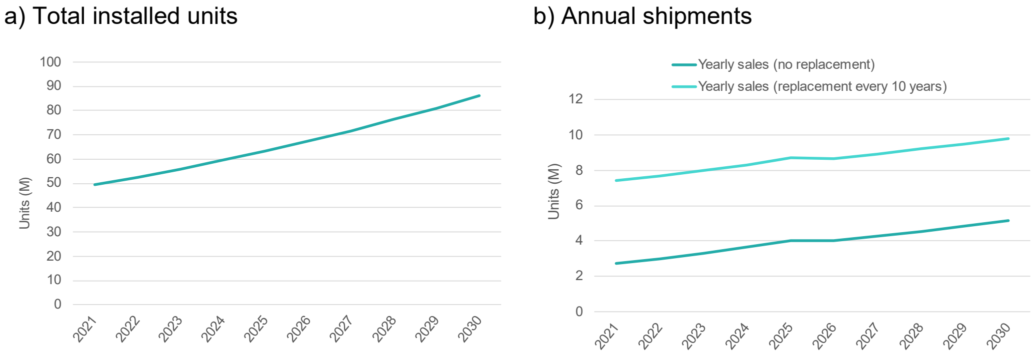
134 https://surecam.com/ (accessed 27.07.2023).

135 This is conservative. Berg Insight forecasts annual global shipments of aftermarket hardware to grow at a compound annual growth rate of 12%. See https://www.berginsight.com/berg-insight-ranks-the-leading-vehicle-telematics-hardware-suppliers (accessed 29.07.2023).

additionally account for replacement of the stock of installed devices by assuming an average IoT telematics device lifespan of 10 years.[136, 137]

131. Figure 14 below shows the active units (left hand panel) as well as the sales per year (right-hand panel) in the 2011-2030 period. We estimate that yearly telematics volumes sold by UK firms in the transport & logistics sector will increase from around 7.4m units in 2021 to around 9.8m units in 2030, while the number of active connections is projected to increase from 49m to 86m in the same period.

Figure 14: Historic and forecasted active connections and annual shipments of cellular transport & logistics telematics units



Source: CRA based on data from Berg Insight (2021).

132. Importantly, the methodology in this section likely materially underestimates the total device sales by UK companies. It relies on a fixed number of IoT projects and companies covered by the 2021 Berg Insight report – and does not account for new projects by existing firms, or new projects by new market entrants which will be developed in the future. It is reasonable to expect that the number of new projects in a nascent and fast-growing market such as cellular IoT will be significant in the coming years.

7.4. SEP licensing issues in the UK telematics sector

133. SEP licensing frictions will have a significant impact on the UK transport & logistics telematics sector in the coming years, to the extent of threatening the commercial viability of UK innovators:

- **SEP holders will soon approach UK companies in the telematics space with royalty claims.** Avanci established its Aftermarket pool at the beginning of 2023.[138] The pool is specifically targeting transport & logistics telematics devices such as "monitoring products" (i.e., trackers and diagnostics devices) and "multi-function devices" (e.g. dash cams and communication devices). Avanci's Vehicle 4G pool targeted automotive OEMs and licenses at the end device level. There is little reason to believe that the licensing strategy in the IoT telematics sector will be any different.

136 See e.g. https://askdashcam.com/how-long-do-dash-cams-last/ (accessed 27.07.2023).

137 We determine past sales to calculate the number of replaced units per year. In the period prior to 2021, we assume that the number installed units has grown in a linear fashion, starting with around 1.1m active units in 2011.

138 https://www.avanci.com/2023/02/20/avanci-launches-aftermarket-licensing-program/ (accessed 28.07.2023).

- **High risk of litigation in the UK telematics sector.** In Section 4.4, we document the aggressive litigation strategy of the Avanci 4G Vehicle pool against automotive OEMs. It can be reasonably expected that Avanci will adopt a similar strategy with its Aftermarket pool targeting IoT innovators.
- **High SEP licensing transaction costs put UK businesses at risk.** Importantly, the UK market for telematics devices is much more fragmented than the market for automotive OEMs, with many SMEs and start-ups developing innovative IoT solutions. There are thus many smaller and less experienced companies in the telematics IoT sector (when compared to their automotive OEM counterparts) which may simply lack the resources to engage in litigations on a level playing field. When faced with litigation and the threat of an injunction, these companies may see themselves forced to either accept inflated royalty demands or be enjoined from the market. In Section 4.2.2, we estimated a conservative transaction cost burden average of £525k per licensee (5% litigation probability), an amount that could certainly pose a threat to the viability of start-ups and SMEs in the UK transport & logistics telematics sector.
- **UK innovators will likely face excessive aggregate royalty burden.** The Avanci Aftermarket pool has published licensing rates for different standards (2G/3G and 4G) and device types (infotainment, multi-function, and monitoring-only).[139] The 4G royalty rates are $15, $7.50 and $4 for infotainment-, other multi-function- and monitoring-only devices, respectively. Avanci's Aftermarket pool as of July 2023 includes 42 SEP holders, covering at most around 61% of all 4G SEPs.[140] This implies an aggregate royalty burden (ARB) for all 4G SEPs of $8.2 for monitoring devices and $12.3 for multi-function devices – assuming that the per-SEP royalty implied by Avanci applies to the entire SEP stack. To put this into perspective: Such an ARB is substantially larger than the ARB implied by *InterDigital v Lenovo* where Mr Justice Mellor determined a FRAND per-unit royalty of $0.175 per cellular unit.[141] Dividing this royalty rate by InterDigital's claimed patent share of approx. 9% yields an ARB of merely $1.94 per unit.[142]

8. APPROPRIATE MEASURES WILL ALLEVIATE SEP LICENSING FRICTIONS IN THE IOT

134. In this section, we discuss a selection of appropriate measures that will facilitate SEP licensing in the UK IoT sector and alleviate licensing frictions. The responses to the IPO's SME survey, the SEP licensing issues reported in the *InterDigital v Lenovo* and *Optis v Apple* judgments, as well as a recent proposal by the European Commission for a SEP Regulation shows the need for improving the SEP licensing framework.[143]

135. First, it is of paramount importance that SEP holder's access to injunctions is limited (Section 8.1). The risk of injunctions against users of standards leads to hold-up, excessive

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139 https://www.avanci.com/vehicle/aftermarket/ (accessed 28.07.2023).

140 Tech + IP Advisory (2022).

141 *InterDigital v Lenovo*, para. 813.

142 *Ibid.*, para 839. The ARB is calculated as $0.175/9%=$1.94.

143 https://ec.europa.eu/commission/presscorner/detail/en/ip_23_2454 (accessed 30.07.2023).

royalty rates and ultimately to reduced investment incentives. Second, component level licensing should be promoted to reduce the transaction cost burden on UK innovators and to further reduce the risk of patent hold-up (Section 8.2). Finally, appropriate measures should foster transparency in licensing negotiations, especially in relation to essentiality assessments and existing SEP licences (Section 8.3).

8.1. Limiting the availability of injunctions

136. In exchange for including patents in standards, Standard Developing Organisations (SDOs) require patentees to commit to making available their patents on FRAND terms. These FRAND commitments are supposed to limit the market power that SEP holders would otherwise obtain after their patents are incorporated in a standard. Because SEP holders who have made FRAND commitments have promised to license their patents rather than seek to exclude other companies from the market, injunctions should therefore not be awarded against firms that are willing to take a licence on FRAND terms.

137. Injunctions, if enforced, have direct negative consequences for UK businesses and consumers. A SEP injunction normally implies that products reading on the relevant standard(s) are enjoined from the market. In the case of smart energy meters, an injunction could mean that the DCC would be forced to cease operation of cellular communication hubs. An injunction therefore deprives UK companies from the return for their investments in the development of innovative products and services and prevents UK consumers from using them.

138. If there remains *a risk* of injunctions being awarded in situations where the implementer is willing to license on FRAND terms, SEP holders will be able to hold-up licensees by threatening to exclude them from the UK market, leading to an imbalance in negotiations, excessive royalty rates and ultimately higher prices for consumers. The risk of implementers being approached by SEP holders with threats of injunctions based on inflated royalty requests is real and was recently confirmed by two UK judgments: In *InterDigital v Lenovo* the court acknowledged that the threat of litigation can lead to a licensee accepting supra-FRAND rates, that the SEP holder InterDigital had approached Lenovo with inflated royalty rates, and that it was reasonable for Lenovo to reject this offer.[144] Similarly, in *Optis v Apple*, the awarded lumpsum was less than 2% of the requested royalty rate, based on which Optis sought an injunction (Section 5.4).

139. The risk of injunctions can stifle innovation on products involving standards, including in the IoT space. If there remains uncertainty that products involving standards will be enjoined from the market, or if SEP holders can misappropriate value in the form of excessive royalties, this undermines the profitability of UK businesses investing in the development of these products in the first place. This risk is also reflected in the UK IPO SME survey. All respondents (9 out of 9) that were involved in an SEP licensing dispute stated that the threat of court-imposed injunctions is a concern for their business.[145]

It is critical to minimise the risk of injunctions against UK businesses in FRAND disputes. While UK courts did not grant injunctions in several recent landmark cases (*Unwired Planet v Huawei, InterDigital v Lenovo*, *Optis v Apple*), there is scope for a further reduction of the risk of injunctions. This could be achieved by clearly establishing that injunctions should

144 *InterDigital v Lenovo* [2023] EWHC 539, paras. 288 and 942.

145 UK IPO (2023), question 29 (see also fn. 36).

not be awarded, except in cases where the implementer refuses to pay a FRAND rate that has been finally determined by a court.

8.2. Reducing transaction costs by means of component level licensing

140. A clear restriction of injunctions is critical but further measures are necessary to contain the risk of hold-up and to minimise SEP transaction costs.

141. In our transaction cost simulation (Section 4.2.2) we show that the transaction cost accruing to UK innovators under component level licensing could be around 99% lower than the cost under end-device level licensing. We further show that the average transaction cost per innovator and per cellular standard under end-device level licensing is substantial and could amount to between £525k (5% litigation probability) and as much as £1.450m (20% litigation probability).

142. Establishing a clear principle that licences must be offered to all requesting parties, including those at the component level, therefore has material scope to reduce the transaction cost burden on UK innovators. This is consistent with the conclusions reached in *Apple v Optis* and in *InterDigital v Lenovo* that the ETSI FRAND obligation requires SEP holders to license to any third party irrespective of their position in the value chain.[146] For some start-ups and SMEs, this could be a critical step in ensuring future commercial viability. More generally, component level licensing could be an important step in ensuring the competitiveness of the UK IoT sector.

143. In addition to reducing transaction cost, component-level licensing can mitigate the hold-up risk by reducing the risk of misappropriation of the value created by downstream innovators. When licensing at the end-device level, there is great scope for SEP holders to misappropriate value created by the downstream innovator. Common practices are to offer inflated ad-valorem rates – or discriminate by use case in the case of per-unit royalty rates. This is particularly true for “high value” applications of the standard. Typically, such high value applications require extensive complementary downstream investments into R&D. Requesting high royalties for high-value applications may violate the principle stated in the CMA’s Horizontal Guidelines and in *InterDigital v Lenovo* that the royalty should reflect the value of the patented technology and not the value of the end device or the use case of the technology.[147]

144. Faced with the risk that a large part of the return on investment may be misappropriated by SEP holders in the form of excessive royalties, innovators may reduce the level of investment or cease production of the relevant product altogether. Moreover, with end device level licensing there is a substantial risk that also the value of downstream innovations is misappropriated by SEP holders. Component level licensing greatly reduces the scope for misappropriation, mainly because of the three reasons discussed in Section 4.3: (i) licensing volumes are higher at the component level licensing, (ii) component manufacturers often have greater expertise to properly evaluate and challenge the demands of SEP holders, and (iii) sunk investments per licensed unit tend to be much smaller at the component level.

146 See para. 73 above.

147 *InterDigital v Lenovo* [2023] EWHC 539 (Pat), paras. 247, 502 and CMA (2023), para. 9.27.

8.3. Promoting transparency

145. The lack of transparency is another critical deficiency of the FRAND licensing system.[148] Because FRAND royalty negotiations and the resulting royalty rates are typically subject to confidentiality obligations, it is very difficult for implementers and courts alike to obtain information about what constitutes fair and non-discriminatory royalties.

146. Innovators in IoT markets such as smart meters or telematics often do not have the financial means or technical know-how to engage in costly licensing negotiations with SEP holders on a level playing field. For instance, SEP holders typically do not provide relevant information on *existing licensing agreements* with other implementers under the guise of confidentiality agreements. Disclosure might be achieved through lengthy litigation, but this step is often unavailable to innovators with limited resources.

147. Issues related to the lack of transparency in FRAND negotiations have been recognized by courts in the past. For instance, the court in *InterDigital v Lenovo* criticizes at several points the refusal by InterDigital to provide adequate information on existing licensing agreements, which significantly impeded Lenovo's ability to make a FRAND counteroffer.[149]

148. Another area with very limited transparency for innovators is the *essentiality* of SEPs. Currently, UK companies bear significant costs from either paying for non-essential IP or for costly essentiality assessments of SEP holders' portfolios. Currently there is inefficient duplication of costs, as essentiality checks for the same declared SEPs are conducted by different implementers.

149. Baron (2023) estimates the cost of an essentiality evaluation per patent at around €5k (~£4,060).[150] Cellular SEP portfolios can easily consist of hundreds or even thousands of patents. Undertaking exhaustive essentiality checks is simply not financially feasible for many potential licensees — although in recent SEP litigation cases essentiality rates of between only 20% and 47% were found.[151] For the 5G standard, a recent report surveyed 15 reports by 6 entities and found industry-wide essentiality rates between 8% and 33%.[152]

150. Appropriate measures to promote transparency could be to establish a repository of SEP licence agreements including information about the determination process of the royalty. Such a repository allows potential licensees to have access to all relevant licences while safeguarding confidentiality requirements. Moreover, independent essentiality checks administered by a well-placed agency (including the UK IPO) should be required before patents are asserted. To economise on costs, essentiality tests can be performed on a randomly selected sample. While essentiality tests are costly, publicly coordinated assessments will *remove* inefficient duplication of essentiality checks and may even *reduce* the total costs of essentiality checks across implementers.

148 Contreras (2019).

149 *InterDigital v Lenovo*, paras. 895, 923, 955.

150 Baron (2023), p.27.

151 Bekkers et al. (2020). Essentiality rates derived from *Unwired Planet v Huawei* and *TCL v Ericsson*.

152 Heyes at al. (2022).

APPENDIX A: REFERENCES

PAPERS, BOOKS, AND REPORTS

Baron, J., Arque Castells, P., Leonard, A., Pohlmann, T., Sergheraert, E. (2023), “Empirical Assessment of Potential Challenges in SEP Licensing”, European Commission, DG GROW.

Baron, J (2023), “Essentiality Checks for Potential SEPs – Framework for Assessing the Impact of Different Policy Options, European Commission”, DG GROW.

Bekkers, R., Henkel, J., Mas Tur, E., Van Der Vorst, T., Driesse, M., Kang, B., Martinelli, A., Maas, W., Nijhof, B., Raiteri, E. and Teubner, L., (2020), "Pilot study for essentiality assessment of Standard Essential Patents," https://publications.jrc.ec.europa.eu/repository/handle/JRC119894.

Berg Insight (2021), “The 500 Largest Cellular IoT Projects Worldwide”, “300 Emerging IoT Projects Worldwide”.

CMA (2023), “Guidance on the application of the Chapter I prohibition in the Competition Act 1998 to horizontal agreements”.

Contreras, J. (2019), “Global Rate Setting: A Solution for Standards-Essential Patents?”, *Washington Law Review,* Vol. 94, No. 2, https://digitalcommons.law.uw.edu/cgi/viewcontent.cgi?article=5067&context=wlr.

Cremers, K., Ernicke, M., Gaessler, F., Harhoff, D., Helmers, C., McDonagh, L., Schliessler, P., van Zeebroeck, N. (2013), "Patent Litigation in Europe", ZEW - Centre for European Economic Research Discussion Paper No. 13-072, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2333617.

Data Communications Company (2022), “Annual Report”, https://www.smartdcc.co.uk/media/hqoh2pyt/annual-report-2022.pdf.

Department for Business, Energy & Industrial Strategy (2019), “Smart Meters Roll-Out Cost-Benefit Analysis”, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/831716/smart-meter-roll-out-cost-benefit-analysis-2019.pdf.

Department for Energy Security and Net Zero (2023), “Smart Meter Statistics in Great Britain: Quarterly Report to end March 2023”, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1159350/Q1_2023_Smart_Meters_Statistics_Report.pdf.

Department for Environment Food and Rural Affairs (2023), “Plan for Water”, https://www.gov.uk/government/publications/plan-for-water-our-integrated-plan-for-delivering-clean-and-plentiful-water.

European Commission (2007), “Enhancing the patent system in Europe”, https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2007:0165:FIN:en:PDF.

Geradin, D. and Katsifis, D. (2021), “End-product-vs Component-level Licensing of Standard Essential Patents in the Internet of Things Context”, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3848532.

Henkel, J. (2022), “Licensing SEPs in the IoT – A value chain perspective”, *Research Policy,* Vol. 51, https://www.sciencedirect.com/science/article/pii/S0048733322001238.

Hayes, J., Zimring, A. and Ladabaum, B. (2022), "A Critical Review of 5G SEP Studies", https://media.crai.com/wp-content/uploads/2022/11/09132755/Critical-Review-of-5G-SEP-Studies_Nov-2022.pdf.

Heiden, B. and Petit, N. (2017), "Patent 'Trespass' and the Royalty Gap: Exploring the Nature and Impact of Patent Holdout", 34 Santa Clara High Tech. L.J. 179, available at: http://digitalcommons.law.scu.edu/chtlj/vol34/iss2/1.

UK IPO (2023), "SEPs questionnaire for SME: Summary of Responses", available at https://www.gov.uk/government/consultations/standard-essential-patents-and-innovation-call-for-views/outcome/seps-questionnaire-for-sme-small-cap-and-mid-cap-businesses-summary-of-responses#interventions-to-the-seps-licensing-framework

Jurata, J. and Luken, E. (2021), "Glory Days: Do the Anticompetitive Risks of Standards-Essential Patent Pools Outweigh Their Procompetitive Benefits?", *San Diego Law Review*, Vol. 58, No. 2, 2021.

Lemley, M. (2000), "Rational Ignorance at the Patent Office," Berkeley Olin Program in Law & Economics, Working Paper Series, Berkeley Olin Program in Law & Economics.

McDonagh, L. and Helmers, C. (2013), "Patent litigation in England and Wales and the issue-based approach to costs", *Civil Justice Quarterly*, Vol. 32, No.3, https://openaccess.city.ac.uk/id/eprint/13850/1/McDonagh%20-%20CJQ.pdf.

Mejer, M. and van Pottelsberghe de la Potterie, B. (2009), "Economic incongruities in the European patent system", *European Journal of Law and Economics*, Vol. 34, No. 1, https://www.proquest.com/docview/1023894025?pq-origsite=gscholar&fromopenview=true.

Microlise (2022), "Safe, Efficient & Sustainable Connected World: Annual Report for 12 Months to 31 December 2022", https://www.microlise.com/investors/wp-content/uploads/sites/5/2023/04/Annual-Report-2022-1.pdf

National Audit Office (2023), "Update on the rollout of smart meters", https://www.nao.org.uk/wp-content/uploads/2023/06/update-on-the-rollout-of-smart-meters.pdf.

Ofcom (2023), "3G and 2G Switch-off", https://www.ofcom.org.uk/__data/assets/pdf_file/0025/252592/3G-and-2G-switch-off.pdf.

Office for National Statistics (2023), "Families and households in the UK: 2022", https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families/bulletins/familiesandhouseholds/2022.

Tech+IP Advisory (2022), "4G-5G SEP Landscape – Patents Declared Through Dec 31, 2021", https://static1.squarespace.com/static/5e77c2b245630059ae9ee9d9/t/6298071d857bc74ef9e20570/1654130465165/2021_4G-5G+SEP+Landscape+Update+2022.06.02+rtp.pdf.

UK Environment Agency (2023), "A summary of England's draft regional and water resources management plans", https://www.gov.uk/government/publications/a-review-of-englands-draft-regional-and-water-resources-management-plans.

UNCTAD (2019), "Digital Economy Report 2019: Value Creation and Capture: Implications for Developing Countries", *United Nations publication*, Sales No. E.19.II.D.17, New York and Geneva.

LEGAL CASES

InterDigital v Lenovo [2023] EWHC 539 (Pat.).

InterDigital v Lenovo [2023] EWHC 1578 (Pat).

Optis v Apple [2023] EWHC 1095 (Ch) (29 May 2023).

TCL Comm. Tech. Holdings, Ltd. v Telefonaktiebolaget LM Ericsson Inc. [2017] Public Redacted Memorandum of Findings of Fact and Conclusions of Law 8:14-cv-00341 (C.D. Cal. Dec. 21, 2017).

Unwired Planet International Ltd v Huawei Technologies Co Ltd [2016] EWHC 410 (Pat 2016).

Unwired Planet International Ltd v Huawei Technologies Co Ltd [2017] EWHC 711 (Pat Ct. 2017).