



Understanding Participation Trends in the Avanci 5G Patent Pool: A Descriptive Analysis

Justus Scharfstädt

Technical University of Munich

Abstract

Patent pools play a critical role in adapting to new technology standards by simplifying the licensing of Standard-Essential Patents (SEPs). The Avanci 5G pool provides a licensing platform for vehicle manufacturers to access essential technologies for connected vehicles. Despite the growing importance of these pools, there is limited research on the dynamics of participation and its implications for different stakeholders. This study provides a descriptive analysis of the Avanci 5G pool, particularly focusing on the development of the SEP and licensee coverage since its inception. It uses a mixed-methods approach and combines multiple data sources for the coverage estimates. My findings reveal substantial growth in both SEP and licensee coverage but highlight a significant gap in the participation of Asian automakers, potentially due to perceived anti-competitive risks. Policy makers and relevant stakeholders should aim to foster a competitive and innovative environment in SEP licensing.

Keywords: patent pool; licensing; connected vehicles; innovation; anti-competitive risks

1 Introduction

Since the 1980s, mobile communications have rapidly gained importance and increasing data demands have driven significant technological advancements Khanh et al. (2022, pp. 1–3). From 1G to 5G, the technology has evolved through five generations.

Large-scale 5G adoption began in 2019, addressing the limitations of previous generations by offering higher data rates, reduced latency, and enhanced connectivity to support the growing Internet of Things (IoT) (Rabbi, 2020). A report published by Statista (2024b) illustrates the remarkable IoT development, with a forecast of more than a doubling from 18 billion in 2024 to 39.6 billion connected IoT devices in 2033. This connectivity enables several “breakthrough” applications including smart cities, smart agriculture, and smart retail Khanh et al. (2022, p. 1).

However, the automotive industry is one that is experiencing a significant impact from the evolution of 5G Lanctot et al. (2023, pp. 4–16). An increase from 450 million connected vehicles in 2025 to over 835 million in 2035 is expected (Statista, 2022). Consequently, the share of connected vehicles will increase from 66% in 2023 to 96% in 2030 (Counterpoint, 2024b; Statista, 2020). A report published by Precedence Research (2024) illustrates that the connected car market is mainly located in Asia Pacific (39%), followed by North America (28%), Europe (25%), Latin America and Africa.

The shift from 4G to 5G is seen as a transformation that enhances vehicle connectivity, safety, and infotainment. This is crucial to improve features like autonomous driving and

remote vehicle diagnostics. As Kasim Alfalahi, CEO of Avanci, states, “5G is no longer the next big thing in the automotive space” Lanctot et al. (2023, p. 3). As a result, 5G car revenues are expected to exceed non-5G car revenues by the latest of 2028 Lanctot et al. (2023, p. 5). According to Counterpoint (2024a), China will lead the connected car market, followed by the United States of America (USA), Japan and Germany.

While vehicles become more connected, the automotive industry is dependent on technology standards that ensure compatibility and functionality across diverse systems (Pohlmann, 2017). These standards are often based on patented technologies, which are known as SEPs if they are necessary for the implementation of the standard Baron and Pohlmann (2018, p. 505). Therefore, Original Equipment Manufacturers (OEMs)¹ need to navigate a complex patent licensing landscape and face potentially high licensing costs (Pohlmann, 2017).

Patent pools, which aggregate SEPs from multiple patent holders, play an important role in simplifying the licensing process by reducing transaction costs and minimizing litigation risks (Lavenue et al., 2023). Since 2016, Avanci acts as a pioneering marketplace for multiple generations of technology patents within the automotive industry (Avanci, 2024h). Building on the success of the 4G pool, Avanci launched their 5G vehicle pool on August 16, 2023, and since then attracted many licensors and licensees (Avanci, 2024f).

Nonetheless, there have been notable developments along SEPs and patent pools in the automotive industry.

¹ In this context, I refer to end-use vehicle manufacturers as OEMs.

First, the European Commission (2023b) published a proposal on SEP regulations to encourage innovation and Fair, Reasonable and Non-Discriminatory (FRAND) access to technology. Second, although patent pools are beneficial to the licensing process, there is ongoing resistance over anti-competitive practices and lack of transparency (ACEA, CLEPA, CEMA, CECE, EGMF, & FEM, 2024; State Administration for Market Regulation, 2024). Third, the creation of counter pools by OEMs highlights their willingness to compete by combining negotiation forces on the licensee side (Bundeskartellamt, 2024).

Given these developments, it is important to elaborate on how emerging technologies and licensing practices are shaping the future of automotive innovation. Despite extensive research, gaps remain in understanding the impact of the participation dynamics in recently established patent pools like the Avanci 5G pool. This thesis seeks to address these gaps by investigating the evolution of SEP licensing and its effects on the automotive industry. Specifically, it analyzes participation trends in the Avanci 5G pool and provides estimates of SEP and licensee coverage developments.

This thesis is organized as follows: Section 2 reviews the literature on standardization, licensing strategies and the role of patent pools. It also derives the research question. Section 3 explains the research methodology and the use of different data sources. After that, Section 4 presents and visualizes the results. Section 5 evaluates the implications of the findings and relates them to the literature to discuss key differences and similarities. Finally, Section 6 summarizes the thesis with some concluding comments.

2 Literature Review and Motivation of Research

A considerable number of studies and research papers covers standardization, patent pools and the overall SEP licensing ecosystem. In this section, I review these terms and look at how to apply them to the automotive industry. Afterwards, I illustrate the derivation of my research question.

2.1 Standardization and Standard-Essential Patents

In recent years, the relationship between technology standards and patents has attracted significant interest from academics and policymakers Baron and Pohlmann (2018, pp. 504–534).

The European Telecommunications Standards Institute (ETSI) defines a standard as a document, created through agreements and approved by a recognized body, that provides rules and guidelines to achieve order in a given context ETSI (2024c, p. 14).

Several industries are dependent on advanced technologies and therefore heavily rely on standardization. In addition, many standards are based on cutting-edge patented technologies, resulting in a large number of innovations protected by SEPs Baron and Schmidt (2019, p. 5).

This important interrelation between standards and SEPs is exemplified by technology-intensive sectors like the information and communications technology industry. Different

networks, from 1G to 5G, enable the development of hyper-connectivity in the IoT, which is crucial for this thesis and the examination of SEP licensing in the automotive industry (European Commission, 2024b).

The literature on standardization identifies three primary categories of standards: de facto, formal and de jure (Bellflamme 2002, pp. 153–176; Chiesa et al. 2002, pp. 431–450; David and Greenstein 1990, pp. 3–41). De facto standards emerge through widespread market adoption and become dominant through popularity or market share. Formal standards are developed and approved by recognized Standard-Setting Organizations (SSOs), while de jure standards are mandated by legislative bodies.

Standards are often developed by SSOs that require their members to license the patented technology that is necessary for the implementation of a specific standard Baron and Pohlmann (2018, pp. 504–534). The main functions of SSOs are discovery, standardization, and regulation Lerner and Tirole (2015, pp. 547–586). Discovery includes understanding and verifying the value of the technology. Shifting market expectations towards the discovered technology is done in the standardization function. With its third function, the regulation, SSOs make sure that SEP holders grant licenses on FRAND terms.

FRAND conditions are a fundamental property of protecting technology implementors with fair royalty rates but also giving an appropriate reward for research and development (R&D) investments and technology availability to the patent owner Lemley and Shapiro (2013, p. 1137). Calculating “fair and reasonable” rates and defining “non-discriminatory” conditions is “*inherently vague*” Geradin (2020, pp. 25–38). The comparable license approach, which analyzes the rates of other similar licensing agreements, is widely used to determine the royalty rate. Alternatively, the top-down approach first calculates the aggregate royalty for all SEPs covering a specific standard, and then distributes this among individual SEPs and their holders Bekkers et al. (2022, p. 5). “Non-discriminatory” means that any company that wants to implement a technology should have access to the respective license and pay the same royalty rate as others.

During the standard development process, SSOs iteratively work in interaction with manufacturers and incorporate various stakeholders’ feedback to ensure comprehensive and effective standards Baron and Pohlmann (2018, pp. 462–503).

In addition to other advantages, standards also ensure safety, reliability, and protect the interests of businesses and users (ETSI, 2024c). Furthermore, standardization shapes the global economy by establishing quality benchmarks, solving connectivity problems, and enabling technological advancement which result in increasing innovation and customer satisfaction Kanevskaia (2020, pp. 161–178).

Despite these advantages, standards also face various challenges and limitations. Verifying FRAND conditions and determining whether patents are truly essential are major issues. Because non-disclosed SEPs can be legally unenforceable and no penalties exist for disclosing non-SEPs,

“over-declaration” can occur. According to a study by the European Commission (2023a), it is estimated that only 20-30% of declared SEPs are truly essential, with even lower tendencies of 10-20% for 5G.

Additional concerns arise as granted SEPs might give the holder a temporary monopoly due to individual price setting and exclusion of implementors that do not agree on licensing conditions Blind and Thumm (2004, pp. 1583–1598). Three reasons for welfare losses related to standards are identified in Barnett (2018, pp. 1321–1324). First, “patent thickets” occur when overlapping patents must be licensed from multiple owners. Second, the situation where numerous patent holders each demand high royalties for their contributions to a single standard is known as “royalty stacking”. Third, “patent holdup” happens when a patent owner demands excessive royalties after a company has already made a significant investment in the technology.

Regarding the SSOs, different approaches for standard setting, including policies on membership, participation, and Intellectual Property Rights (IPRs) management might lead to inconsistency and conflicts with the approaches of other SSOs Baron and Pohlmann (2018, pp. 462–503).

Overall, while “*standardization is a key contributor to industrial innovation and competitiveness*” European Commission (2023b, p. 1), it also faces challenges that require careful management and regulation to ensure FRAND access to essential technologies.

To address these issues, the European Commission (2023b) proposed a regulatory framework for SEPs in April 2023. They seek to benefit European Union (EU) consumers and businesses by promoting the use of standardized technologies, fostering innovation within the EU, and encouraging competitive participation in EU and global markets. The feedback on this issue shows a mixed perception among the stakeholders (European Commission, 2024a). Several licensors and research groups are concerned about slowing down the negotiation process, reducing R&D investment and having a negative impact on international competitiveness. On the other hand, consumer groups and licensees, including Mercedes-Benz (Muller, 2023), support the proposal to ensure transparency, fairness and a more balanced SEP ecosystem.

In a completely different approach, the United Kingdom (UK) Intellectual Property Office launched a SEPs Resource Hub² that gathers SEP-related information and aims to assist UK businesses in navigating the complex licensing landscape (UK Government, 2024). It is the first of its kind and has been developed in collaboration with industry stakeholders (Brazier, 2024).

2.2 Types of Licensors

The licensors, or patent owners play a crucial role in the licensing ecosystem. This section provides a detailed examination of the different categories of licensors and highlights their functions and strategies within the market.

In this context, Dewatripont and Legros (2013, p. 928) distinguish between upstream and vertically-integrated firms. First, upstream firms operate at the initial stages of the production process and develop technologies. Licensing revenues often cover their R&D costs and therefore increase profits. Their business model incentivizes them to engage in patent “padding”, i.e. increasing the number of patents, even if some are not essential. Second, vertically integrated firms develop technologies and generate licensing revenues (upstream) but also utilize external licenses to manufacture goods (downstream). This leads to a more balanced motivation to declare patents.

In addition to generating revenues through licensing patented technologies, patent owners have the option to sell their IPRs. They may choose to divest to other licensors, as exemplified by the patent assignment from OPPO to ZTE (Müller, 2024b). Such transactions are often strategic decisions to resolve litigation disputes and optimize their portfolios.

Furthermore, patents can also be sold to Non-Practicing Entities (NPEs) that do not engage in own development but strategically acquire IPRs to enforce and license them Schwartz and Kesan (2014, pp. 426–456). By that, NPEs can also mitigate the risk of high litigation costs for smaller inventors Cohen et al. (2018, p. 2). However, the presence of NPEs introduces a layer of complexity in patent licensing and NPE transferring. Especially the aggressive “*you pay immediately or we go to court*” strategy European Commission (2014, p. 67) leads to rising defense costs. Data from the European Commission (2014, p. 68) indicate that the activities of NPEs, specifically SEP transfers, have increased significantly since 2005.

2.3 Types of Licensees

On the opposite side of the licensing agreement are the licensees. This section examines the distinction between licensing to end-product manufacturers and component suppliers.

In a multi-layered supply chain, patent owners can primarily license their technology to component suppliers or end-product manufacturers. Geradin and Katsifis (2021, p. 8) evaluate the debate on whether SEP holders must license to all implementers, including component suppliers, or can choose to license only at the end-product level. On the one hand, supporters of supplier licensing argue that it can potentially lower transaction costs, prevent over-compensating SEP holders with excessively high royalty rates, and reduce legal uncertainty for component manufacturers operating without a license. On the other hand, proponents of licensing SEPs only to end-product manufacturers state that this approach aligns with traditional industry practices and ensures fair compensation for the patent owners. Nonetheless, Martinez (2019, p. 649) stresses that component suppliers have low profit margins and are therefore unable to pay “adequate” royalties to SEP holders.

² UK SEPs Resource Hub

The Nokia vs. Daimler case serves as a pertinent example that illustrates the licensee differentiation problem (Raturi, 2021). In 2019, Nokia sued Daimler for using telematic control units without a license, but Daimler, being an end-product manufacturer, argued that its suppliers should obtain the licenses. In August 2020, the Mannheim Regional Court decided that Daimler did not show willingness to obtain a license and granted Nokia injunctive relief. Following the decision, the Bundeskartellamt suggested that the court should refer competition concerns to the European Court of Justice to address whether SEP-holders can choose which supply chain entities to license. However, the Mannheim Court refused this (Klos, 2020; Raturi, 2021).

Several challenges arise from the refusal to license SEPs to component suppliers. The competition rules published by the European Commission (2017) state that licensing a SEP under FRAND conditions means that it “*should be available to any potential user of the standard*”. Furthermore, SEP holders might reduce competition by withholding licenses that are necessary for manufacturing and selling standard-compliant products Nazzini (2017, p. 21).

Examples for licensing only to end-product manufacturers and refusing to license component suppliers exist, namely the Avanci patent pools (Muller, 2022). In 2019, the automotive component supplier Continental sued Avanci for this behavior Koh (2019, p. 2).³ In contrast, the Via Licensing Alliance (2024) follows another approach and offers licenses to manufacturers, suppliers, and other potential users.

Despite the decision on whom to license to, there is another important development around licensees, particularly connected vehicle manufacturers. In February 2024, Toyota, previously only a licensee, acquired multiple SEPs from the electronics manufacturer and SEP licensor OPPO (Müller, 2024d; Shan, 2024). With deals like this, licensees aim to solve the “patent dilemma”, which refers to the disadvantages they face in SEP litigation against licensors. Benefits of such deals include the possibility to counter sue, having a broader portfolio, and using acquired patents for licensing agreements to lower own licensing costs. However, this also adds further complexity to the licensing ecosystem.

2.4 The Role of Patent Pools

To bridge the gap between licensees and licensors, patent pools serve as a critical mechanism. In the following, I analyze their objectives, features and development.

Literature shows that licensing negotiations are expected to become more complex, which makes it important for patent owners to provide a variety of licensing mechanisms Nikolic and Galli (2021, pp. 1–8). Licenses can be obtained through bilateral agreements between licensees and licensors, which are often resource-intensive and time-consuming, or via a joint licensing arrangement, such as a patent pool SEPs Expert Group (2021, p. 27).

Dequiedt and Versaevael (2013, p. 59) define patent pool as “*cooperative agreements between two or more firms to license their related patents as a bundle*”. To access this bundle, a royalty rate needs to be paid to the pool, which is then divided among the licensors. Thereby, patent pools enable a streamlined licensing process with reduced transaction costs and litigation uncertainties as well as predictable licensing costs. The “one-stop shopping” feature highlights efficiency and access advantages for many market participants.

That said, the presence of patent pools can also result in negative effects on competition and innovation SEPs Expert Group (2021, p. 27). There is a risk of anti-competitive practices, such as price-fixing, market fragmentation or excluding potential users. Patent pools therefore have to comply with several conditions: the patents included need to be essential and verified by independent third parties, members agree to follow FRAND conditions, and licensors must keep the right to license their patents independently.

Historically, patent pools have been the earliest form of patent aggregation that first emerged in the USA in the late 19th century Nikolic and Galli (2022, p. 4). After initially facing antitrust problems in mid-1900s, they re-emerged in the 1980s for audio-visual technologies. Regarding IoT networks, a study by Pohlmann (2015) found that patent pools were not common for technology standards. In 2015, only 9% of globally declared SEPs were licensed through pools.

This low adoption can be explained by three factors. First, licensors do not want to lose leverage when negotiating cross-licensing agreements. Second, the maximum price of the pool might be below the one favored by the patent owner. Lastly, the complexity and high setup costs make it difficult to agree on conditions with all stakeholders of a patent pool (Nikolic and Galli 2022, p. 4; Pohlmann 2015).

However, multiple key developments mark the evolution of patent pools. “*Major signals*” for increasing importance and industry coverage of patent pools are analyzed by Mossoff (2023). Over the past two decades, patent pools have emerged in numerous innovative industries, including eye surgery, audio technology, smart TVs, 4G and 5G, among many others. The significance is underlined by the success of the Avanci 4G vehicle pool, which covers over 80% of connected cars (Müller, 2024c), and the merger of Via Licensing and MPEG LA to form the Via Licensing Alliance (Via Licensing Alliance, 2023), the largest patent pool in history.

Although this trend is evident, resistance partially remains. Several parties criticize patent pools and raise concerns on lacking FRAND conditions, non-transparent information, and call for monopoly risk assessments related to pools’ licensing practices. This is exemplified by two recent letters⁴ addressed to the Avanci 5G vehicle pool (ACEA, CLEPA, CEMA, CECE, EGMF, & FEM, 2024; State

³ Continental, the plaintiff, argued that Avanci’s unfair approach aims to uphold the high royalty rates that only vehicle manufacturers with higher profit margins can afford.

⁴ Six automotive groups express the need of transparency about essentiality verification and the royalty rates, and the Chinese State Administration for Market Regulation reminds of the risk of monopolistic licensing activities.

Administration for Market Regulation, 2024). After the US Department of Justice ruled that Avanci's pool are unlikely to harm competition and the EU took steps to enhance transparency, China is now challenging the pool's activities (Chun, 2024).

Additionally, a recent development goes beyond the written resistance: the approval for a licensing negotiation group (LNG)⁵, which plans to lower negotiation efforts and transaction costs by combining the strength of multiple licensees (Bundeskartellamt, 2024). Despite this, patent owners fear that counter pools could grant too much power to the licensees. Although the formation is approved, the Bundeskartellamt (2024) emphasizes several conditions for LNGs: voluntary participation, restricted activities, and a maximum 15% share of the purchasing market that must not be exceeded. Schüll (2024), patent attorney and partner at Cohausz & Florack, says that the decision of the Bundeskartellamt proves that “Germany and the EU play a leading role in the field of SEPs”.

This development follows other relevant agreements in the licensing landscape. Patent pools already agreed with LNG-like companies that operate as patent aggregators, as exemplified by two licensing agreements of Sisvel and RPX (Dini, 2024).⁶ The collaborations of patent pools and patent aggregators demonstrate the efficiencies of working together in terms of reduced transaction costs and balanced interests of patent owners and technology implementors (Houldsworth, 2024). Therefore, other licensees may be incentivized to form LNGs as well.

2.5 Derivation of the Research Question

The literature review underscores the increasing significance of SEPs and patent pools in the licensing ecosystem. The integration of technology standards, particularly SEPs, involves navigating complex challenges.

On one hand, patent pools might be a potential solution to some of these challenges by streamlining licensing processes, reducing transaction costs, and mitigating litigation risks. On the other hand, the successful establishment of patent pools depends on multiple factors including attracting new members. Recent developments in the licensing landscape reveal ongoing resistance, critical concerns, and the formation of counter pools, the implications of which remain unclear. Further, different regulatory frameworks are proposed.

As patent pools continue to evolve rapidly, it becomes essential to evaluate the participation trends and determine the pool's coverage of SEPs and licensees. There is a literature gap regarding the analysis of participation trends in newly established licensing models such as the Avanci 5G vehicle pool. Therefore, this thesis aims to fill the existing gap by

providing valuable and detailed insights into the emerging dynamics within the Avanci 5G pool. It discusses broader implications for OEMs, patent owners, and regulators. As a result, I formulate the following research question:

How have the patent and licensee coverage evolved within the Avanci 5G pool since its inception?

3 Research Method

This section outlines the research methodology employed in this study, including the utilization of different data sources for the Avanci 5G pool, its members, SEP and licensee coverage calculations, revenue estimations and related court cases. The analysis covers the period from the launch of the Avanci 5G pool on August 16, 2023, (Avanci, 2024b) until August 31, 2024.

3.1 Presentation of the Avanci 5G Pool

Beginning with Avanci, which positions itself as “the independent global leader in joint licensing solutions” (Avanci, 2024e), the pool administrator offers patent pools across various industries, including vehicles, IoT and broadcast (Avanci, 2024h). This thesis focuses on the vehicle sector, particularly the 5G pool (Avanci, 2024c).

Compared to the 4G pool, the 5G pool covers SEPs for 2G, 3G, 4G and 5G technology (Avanci, 2024f). This includes the Vehicle-to-Everything connectivity that enables communication to other vehicles, pedestrians, and the overall infrastructure. The Avanci 5G pool states that it features “market-driven pricing”, which can be divided into two different royalty rates. According to an interview with Avanci vehicle president Laurie Fitzgerald (Jiang, 2024), the pricing structure was established based on feedback from multiple stakeholders. The \$29 per vehicle “early-licensee pricing” applies to all licensees who sign the license agreement before February 16, 2024, or before their first 5G connected vehicle sale. Depending on the case, “other conditions apply” (Avanci, 2024c). The “base running royalty” amounts to \$32 per vehicle, resulting in a 60% increase compared to the \$20 of the 4G pool (Avanci, 2024a). Avanci (2024f) also states that the prices might change in the future.

The Avanci 5G pool seeks to transform shared technology by securing licensors' SEPs and providing licensees with a broad patent coverage, both optional and on FRAND terms (Avanci, 2024f). Consequently, it aims to increase efficiency in terms of reduced negotiation time and transaction costs.

3.2 Data Collection of Avanci Members

To create a foundation for the descriptive analysis of the Avanci 5G pool, it is essential to determine the joining dates of the participating licensors and licensees.

There are multiple ways to collect the joining dates. I start by monitoring the members' websites and social media

⁵ The “Automotive Licensing Negotiation Group” was requested by Volkswagen, Mercedes, BMW and ThyssenKrupp.

⁶ Sisvel, owner of multiple patent pools, and RPX, a patent aggregator for approximately 320 technology implementors, made licensing agreements for WIFI and Video SEPs.

statements, for example on LinkedIn⁷. Additionally, Avanci announces new entrants on their “News & Views” page⁸ and displays the corresponding logos on their website. Industry experts and blogs related to SEPs and the licensing ecosystem also post regular updates on the Avanci 5G pool. For instance, Florian Müller, author of the blog *ip fray*⁹ (formerly Foss Patents¹⁰), provides “*in-depth reporting and analytical commentary on intellectual property disputes and debates*” (Müller, 2024a). IAM Media¹¹ exemplifies another source with news articles on patent updates within the automotive industry.

However, these sources do not capture all joining members. To address this limitation, I employ the Internet Archive Wayback Machine¹², following the approach of Baron and Ménière (2014, p. 55) who evaluate descriptive statistics for patent pools. This approach enables me to track the joining dates approximately by comparing the member logos across different versions of the Avanci 5G pool website. Given that not all logos are consistently published on the website, my data collection is based on a combination of the mentioned sources. Appendix 1 lists all participating licensors and licensees with their entry dates.

For each licensee, I further assess whether they joined before or after the royalty rate increase on August 16, 2024. However, it is beyond the scope of this thesis to track the timing of their first 5G-connected vehicle sale to determine whether those who joined after the price increase actually pay the higher rate. Nonetheless, I examine two other company-specific characteristics of the licensees: their headquarter locations and vehicle segment.

3.3 Collection of ETSI Data

To obtain the necessary data to address the research question concerning the SEP coverage of the Avanci 5G pool, I need to assess the share of SEPs held by Avanci licensors compared to the total number of SEPs declared.

The starting point for the analysis is set with an extract of the ETSI IPR database that is released twice a year in the special report SR 000 314 (ETSI, 2024b). In its report, ETSI (2024a, p. 4) mentions that it does not verify the relevance or essentiality of declared patents or patent applications. Moreover, the SSO does not conduct any research on other patents that might be or become essential. However, if ETSI members become aware of any essential IPR, they are obliged to make “*reasonable efforts*” to notify ETSI.

I use the version V2.35.1 of the ETSI special report, that was published in April 2024 and contains 1,044,211 entries in its raw format. To identify all unique patents disclosed to ETSI, I follow an approach similar to the one used by Bekkers et al. (2020). In the first step, I keep only the relevant entries by cleaning the raw data using the following fields:

1. ‘**COMP_LEGAL_NAME**’ is the “*legal name provided by the declarer to identify the declarant company*” ETSI (2024a, p. 14).
2. The columns ‘**2G, 3G, 4G, and 5G**’ indicate whether “*any of the disclosed standards/work items/specifications disclosed 3GPP technologies correspond to ‘2G’, ‘3G’, ‘4G’, or ‘5G’*” ETSI (2024a, p. 16).
3. ‘**DECL_IS_PROP_FLAG**’ shows “*whether the declarant and/or its affiliates declared to be the proprietor of the IPR(s) disclosed in the attached IPR Information Statement Annex, or not*” ETSI (2024a, p. 14).
4. ‘**Ess_To_Standard**’ indicates “*whether the patent is disclosed as essential to a specified standard/work item/specification*” ETSI (2024a, p. 15).
5. ‘**PATT_ID**’ is a “*unique numeric identifier of a patent in the IPR database*” ETSI (2024a, p. 15).
6. **PATT_APPLICATION_NUMBER** identifies the “*patent application number of the patent identified by PATT_ID*” ETSI (2024a, p. 15).
7. **PUBL_NUMBER** is the “*patent publication number of the patent identified by PATT_ID*” ETSI (2024a, p. 15).
8. ‘**IPRD_SIGNATURE_DATE**’ indicates the “*date of the IPR declaration submission to ETSI*” ETSI (2024a, p. 14).
9. ‘**DIPG_PATF_ID**’ is the “*unique numeric identifier of a disclosure’s ETSI patent family in the IPR database*” ETSI (2024a, p. 15).

Afterwards, I add the field ‘**COMP_NAME_CONSOLIDATED**’ to display the correct consolidated names for the relevant applicant companies. Table 1 shows the cleaning process at patent family level, including the additional step 11, and the remaining entries after the different steps.

Bekkers et al. (2020, p. 11-14) eliminate duplicates with the same **PATT_APPLICATION_NUMBER**, **PUBL_NUMBER** and **DIPG_PATF_ID**. After this step, some duplicates with identical **PATT_ID**s remain. Therefore, they try to identify all relevant ETSI patents in combination with the **PATSTAT**¹³ database released by the European Patent Office. Their procedure with its materials and proficiency exceeds the scope of this thesis. My methodology includes several other steps to reach a useful approximation.

I start my data cleaning process by eliminating all entries without a **COMP_LEGAL_NAME**, as these entries are not associated to any legal entity. For the focus of my research, I further ensure that only patents corresponding to 2G, 3G, 4G or 5G (identified by a ‘1’ entry) remain. After that, setting **DECL_IS_PROP_FLAG** to true ensures that the respective declarants are also the proprietors of the IPR. In the

⁷ LinkedIn

⁸ Avanci “News & Views”

⁹ ip fray

¹⁰ FOSS Patents

¹¹ IAM Media

¹² Wayback Machine

¹³ European Patent Office PATSTAT

Table 1: ETSI data cleaning process at patent family level

Steps	Patent family level	# Entries
0	Raw	1,044,211
1	Remove (blank) COMP_LEGAL_NAME	1,044,111
2	Remove (blank) 2G-5G	943,868
3	Set DECL_IS_PROP_FLAG = TRUE	943,809
4	Set Ess_To_Standard = TRUE	941,632
5	Remove "" OR "-" PATT_APPLICATION_NUMBER	919,135
6	Remove (blank) OR "" OR "n/a" OR "-" OR "pending" PUBL_NUMBER	857,187
7	Remove duplicates using PATT_ID	224,877
8	Remove duplicates using PATT_APPLICATION_NUMBER	216,750
9	Remove duplicates using PUBL_NUMBER	184,059
10	Sort IPRD_SIGNATURE_DATE ascending	184,059
11	Remove duplicates using DIPG_PATF_ID (- 1 blank)	75,528
12	Add COMP_NAME_CONSOLIDATED with consolidated licensor name	75,528

fourth step, I remove all patents that are disclosed as non-essential by setting `Ess_To_Standard` to true. Furthermore, there are several irrelevant entries in the `PUBL_NUMBER` or `PATT_APPLICATION_NUMBER` fields that contain missing or unusual values (e.g. “na”, “pending” or “-”) that I delete as well. After eliminating irrelevant entries, I focus on duplicates. The report published by ETSI (2024a, p. 15) states that the `PATT_APPLICATION_NUMBER` and `PUBL_NUMBER` are identified by the `PATT_ID`. Nonetheless, I believe that it would be insufficient to eliminate entries based only on the `PATT_ID`, as duplicates with identical values in the other two fields may remain because of database updates or corrections. Thus, I check for duplicates in all three fields individually. To retrieve the remaining records with the oldest disclosure dates, I order them in ascending order based on the `IPRD_SIGNATURE_DATE`. This is also done by Bekkers et al. (2020, p. 13). I perform an additional step for the analysis at patent family level: duplicates are further eliminated using the `DIPG_PATF_ID`.

All the steps lead to a remaining set of 184,059 entries at patent- and 75,528 at patent family level, significantly less than the initial 1,044,211.

Lastly, I ensure that all licensors are accurately listed on company level by adding the field `COMP_NAME_CONSOLIDATED`. For instance, I aggregate “NOKIA MOBILE PHONES” and “Nokia Corporation” to “Nokia”. In this context, it is necessary to note that for some NPEs, information on the number of patents they hold are unavailable.¹⁴ Con-

sequently, I transfer the patents to the NPE only if online sources provide proof of ownership. Sterzi et al. (2020, p. 4) also highlight this problem of limited transparency of patent ownership and mention that NPEs are “*gaming the system*”, which “*poses serious challenges to competition authorities and regulators*”. Appendix 2 shows the licensor consolidation and monthly SEP analysis at patent level.

3.4 Collection of Judicial Data

Court cases and judicial rulings significantly impact the licensing ecosystem, specifically negotiation strategies and patent pool participation trends OECD (2019, pp. 24–36).

To get an overview of ongoing court cases and recent judgements regarding automotive SEP licensing and the Avanci 5G pool, I review multiple online sources. As already stated in the Data Collection of Avanci Members (see section 3.2.), `ip fray`¹⁵ (formerly FOSS Patents¹⁶) regularly posts detailed updates on relevant judicial data.

For this thesis, I begin by looking for cases where Avanci licensors are plaintiffs and potential licensees are defendants. However, there is not a single 5G infringement case between an Avanci licensor and a vehicle manufacturer (Müller, 2024c). Therefore, I also analyze cases with Avanci licensees acting as defendants against potential licensors. Furthermore, judicial rulings involving Tesla are also relevant for my research because the automaker holds an Avanci 4G license and tries to get a preferential 5G rate (Müller, 2024c).

¹⁴ Applies for: 5G IP Holdings, China Mobile, China Telecom, China Unicom, Coolpad, Crystal Clear Codec, Emergent Mobile, EQUO Innovative Partner, Harfang IP, Intellectual Discovery, IP Innovation, JVCKENWOOD, KDDI, MiiCs, New Radio, Nippon Telegraph and Telephone, Offino, Oswego, Technology in Ariscale, TNO, Top Quality Telephony, UU Ventures.

¹⁵ `ip fray`

¹⁶ FOSS Patents

3.5 Data Consolidation and Processing

Following the collection of all relevant information and data needed for the descriptive analysis, I will consolidate these to get an overview, extract key findings, and visualize them in form of figures and tables.

The participation trends of the licensors and licensees provide a good starting point. Building on that, I use the proportion of participants joining at each date for a time-to-license calculation.

For the first part of the research question, the SEP coverage estimation, it is essential to combine the licensor and ETSI data. I collect the amount of SEPs covered by comparing the participating licensors' joining dates (see section 3.2) with the IPRD_SIGNATURE_DATE and their name with the COMP_NAME_CONSOLIDATED. The Avanci share is then calculated by dividing the amount held by the members by the total number of declared SEPs.¹⁷ I perform this calculation at patent- and patent family- as well as monthly- and quarterly level, resulting in 13 and 4 observations per licensor, respectively. However, it is important to note that my results could differ from the actual SEP coverage of the Avanci 5G pool.

For the second part of the research question regarding the licensee coverage estimation, I begin by compiling a list of OEMs worldwide, ranked by revenue. Although Avanci's licensees produce passenger, industrial, agricultural and defense vehicles¹⁸, this thesis targets only passenger vehicles. I create a python web scraper that uses the list of 147 automakers published by Statista Passenger Cars Worldwide¹⁹, which includes their headquarters locations and revenue forecasts for 2024. I also manually add Polestar and VinFast to the list, as they are not included.²⁰ All passenger car manufacturers with a forecast of less than USD 10 million are removed to exclude unnecessary players, leaving 129 OEMs. To estimate the licensee coverage of the Avanci 5G pool, I identify which OEMs from the list hold a license. This results in two coverage estimates: geographic by continent and financial by revenue. While the geographic coverage is analyzed as of August 31, 2024, the revenue coverage development is evaluated monthly from August 31, 2023, to August 31, 2024.

It is crucial to recognize that it would be inaccurate to assume that all revenues will be generated through connected cars. The share of revenues from connected cars can vary significantly depending on the company's focus. Given the scope of this thesis, I follow the estimation used by Counterpoint (2024b) and apply a fixed amount of 66% for all OEMs. To calculate the coverage, I divide the cumulative projected

connected car revenues of the OEMs participating in Avanci by the total forecasted connected car revenues for the entire automotive market.

I also apply the 66% share for another insightful estimation: calculating the total revenue generated by the Avanci 5G pool in 2023 and 2024.²¹ I collect the 2023 vehicle sales for all licensees using the information from their websites and press releases.²² For 2024, I forecast an average increase in connected car sales of 2.3%, which is also predicted by Statista (2024a) for the overall automotive market. To estimate the licensees' payments, I multiply their connected vehicle sales (66% of their total unit sales) by the royalty rate they pay to Avanci. While \$29 applies to all OEMs that joined in 2023, the rate ranges between \$29 and \$32 for the ones that joined after February 16, 2024. This calculation is performed in two ways: based on the number of days the licensee was part of the pool within the year and based on the quarters during which the licensee was active. Therefore, I assume that the vehicle sales are evenly distributed throughout the year.

4 Results

This section presents the key findings derived from the research method steps outlined above.

Beginning with the participation of the Avanci 5G licensors and licensees, Figure 1 illustrates the development of Avanci members from August 2023 until August 2024. The marks on the line indicate a new entrant. There has been an increase for both groups since the pool's inception on August 16, 2023. Initially, the pool started with 59 participants, of whom 58 were licensors and one was a licensee, namely Mercedes-Benz (Pohlmann, 2023). Over the next 12 months, the number of licensors grew by approximately 19% to 69, with OPPO being the last one that joined on July 31, 2024 (Ma, 2024). The licensees increased to 33 participants, with the Renault Group joining as last the OEM on August 26, 2024 (Avanci, 2024e). During the notable licensee increases in February, the VW Group joined the pool with 14 vehicle brands (Avanci, 2024g). Moreover, one third of the licensees joined before the royalty rate increased from \$29 to \$32 on February 16, 2024.

To compare the participation trends from another perspective, Table 2 provides the time-to-license distribution on a daily basis. While the 69 licensors joined within 350 days from the inception, it took the 33 licensees 376 days. The highest percentage of licensors (84.1%) joined immediately whereas most licensees (42.4%) joined after 188 days. Thus, the licensors' average time-to-license of 32.2 days is significantly lower than the 182.7 days for the licensees.

In addition to the previous results, the SEP coverage marks one of the research highlights. Figure 2 illustrates the

¹⁷ Toyota's acquisition of 5G SEPs from OPPO is not taken into consideration.

¹⁸ Saab produces defense vehicles. Iseki, Kobelco, MAN, Navistar, Scania, VW Truck & Bus and Yanmar manufacture industrial and agricultural vehicles but Statista (2023) identifies Deere & Company, CNH Industrial, Kubota, AGCO Corporation and Claas as global market leaders in this industry by revenue.

¹⁹ Statista Passenger Cars Worldwide

²⁰ Scout will not start their production until 2026, and Cupra did not publish their revenue for 2023 or 2024. Therefore, I do not add them.

²¹ I assume that the 66% share also applies for the manufacturers of agricultural and industrial vehicles.

²² Iseki, Kobelco, Saab and Yanmar did not publish their unit sales for 2023.

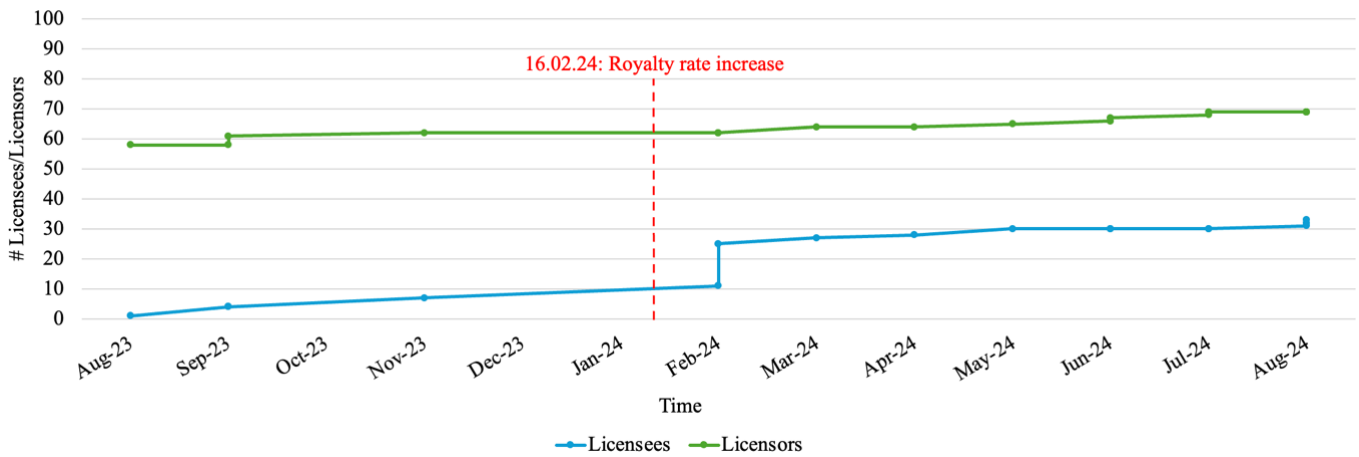


Figure 1: Number of Avanci 5G licensees and licensors (monthly)

Table 2: Time-to-license overview for licensees and licensors (daily)

Days	# Licensees	Share	# Licensors	Share
0	1	3.0%	58	84.1%
23	3	9.1%		
42			3	4.3%
83	3	9.1%	1	1.4%
181	4	12.1%		
188	14	42.4%		
222	2	6.1%	2	2.9%
256	1	3.0%		
276	2	6.1%	1	1.4%
300			1	1.4%
302			1	1.4%
344			1	1.4%
350			1	1.4%
356	1	3.0%		
372	1	3.0%		
376	1	3.0%		

between October and November 2023 and June and July 2024. During the first jump, Intel joined on October 11, 2023, with 2,191 patents at patent level and 1,147 patents at patent family level (Lovatt, 2023). During the second one, OPPO signed an Avanci license with 11,583 patents at patent- and 5,204 patents at patent family level on July 29, 2024 (Ma, 2024).

The next assessment estimates the licensee coverage of the Avanci 5G pool. Globally, the combined connected car revenue of 129 major car manufacturers is projected to reach approximately USD 1,371 billion in 2024. 79 of these companies are headquartered in Asia, while 39 are in Europe and 11 in the USA. The 25 carmakers participating in Avanci are also headquartered on those three continents, but their distribution is significantly different. Avanci’s licensees are concentrated in Europe (15) and the USA (6), with only 4 in Asia. Despite the generally large number of 56 OEMs in China and 11 in Japan, none hold an Avanci 5G license. In contrast, Europe, especially countries like Sweden and Germany, show high participation rates.

Besides the geographic coverage, Figure 3 presents the licensee revenue coverage development monthly. With the participation of multiple carmakers, the cumulative projected connected car revenue of the Avanci licensees increased by more than nine times from USD 67 billion in August 2023 to USD 619 billion in August 2024. As a result, the coverage of the total project connected car market revenues increased from 4.9% to 45.2% over this one-year period. Three major jumps occurred in September 2023, November 2023 and February 2024. While the BMW Group joined in the first one (Avanci, 2023a), the Hyundai Motor Group joined in the second (Avanci, 2023b) and the General Motor Company (Avanci, 2024d) and Volkswagen Group (Avanci, 2024g) in the third one. Nonetheless, among the ten largest players, Toyota, Honda, Nissan, BYD and Tesla still not entered the pool. Appendix 3 illustrates the licensee coverage calculation.

The increasing licensee coverages leads to the total rev-

development of the 2G-5G SEP coverage of the Avanci 5G pool from August 2023 to August 2024 at patent- and patent family level. The number of patents included in the Avanci 5G pool rose from 151,469 to 165,428 at patent level and from 58,160 to 64,559 at patent family level. Consequently, both coverages developed almost in parallel. While the coverage at patent family level increased from 77% to 86%, the coverage at patent level grew from 82% to 90%. That said, there was no development between November 2023 and June 2024. Two larger increases can be observed

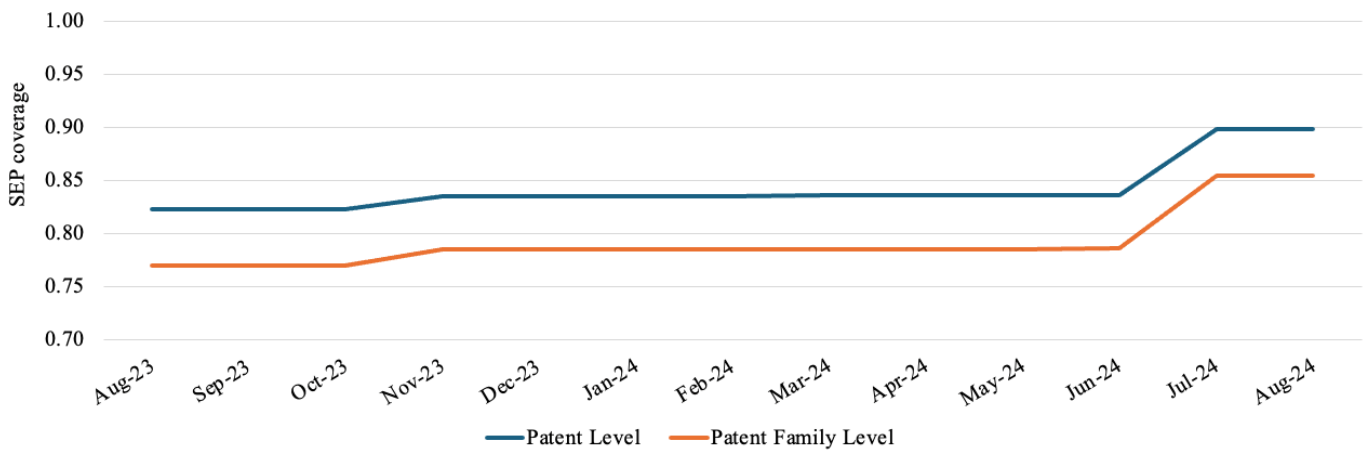


Figure 2: Avanci 2G-5G SEP coverage development (monthly)

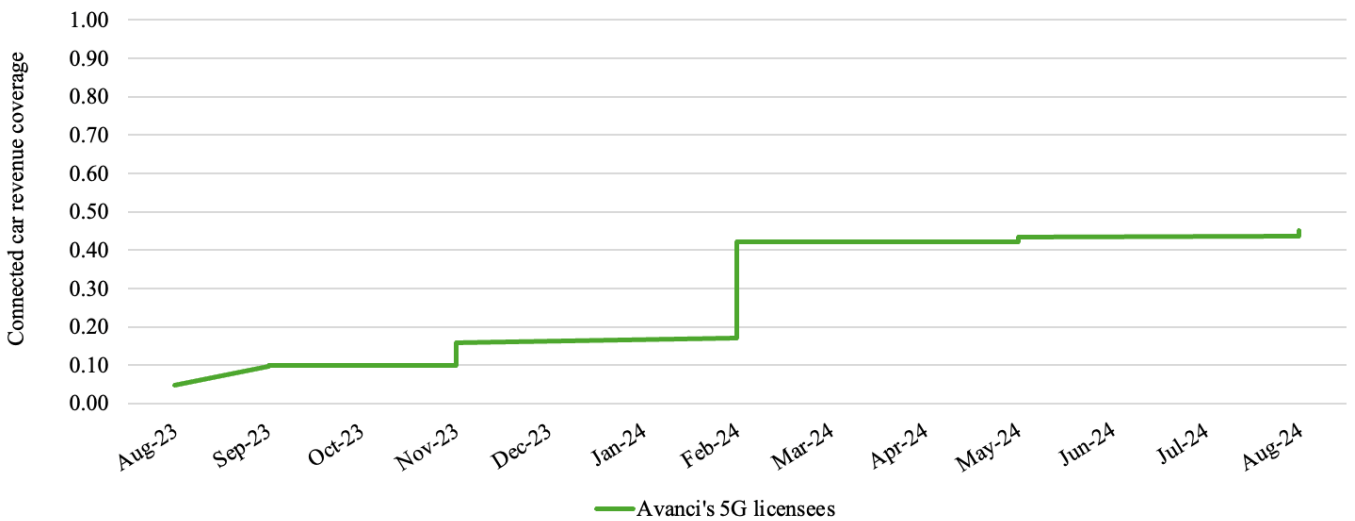


Figure 3: Avanci licensee coverage development (monthly)

enue generated by the Avanci 5G pool in 2023 and 2024. In 2023, the seven participating OEMs sold over 12.6 million connected vehicles and contributed around \$54.5 million for the daily consideration and approximately \$84.4 million for the quarterly consideration of their Avanci 5G license payments. With 25 new licensees in 2024, the vehicle sales and the pool administrator’s revenue will increase significantly. Based on the estimated average growth rate of 2.3% in unit sales for all OEMs, Avanci’s licensees are projected to sell over 29.7 million connected vehicles in 2024.²³ Brands like Volkswagen, Hyundai, Kia and Mercedes-Benz have the highest sales. As a result, depending on the rates applied to the licensees that joined after the price increase in February 2024, the revenue is expected to range between \$495.5 million and \$515.6 million for the daily consideration. This represents

a year-over-year growth of 807% to 946%. In contrast, the quarterly calculation projects revenues of \$539.1 million and \$564.1 million for 2024, indicating an increase of 539% to 669%. Appendix 4 illustrates the Avanci revenue calculations for 2023 and 2024.

Besides the Avanci specific data and results, there are other observations around court data related to automotive connectivity and the broader SEP licensing ecosystem. First, it is important to note that there are no ongoing court cases where an Avanci licensor acts as a plaintiff against a potential licensee as a defendant.

Only one recent case, which was dismissed on July 15, 2024, involved Avanci and one of its members as defendants (Fancourt, 2023). In that case, Tesla tried to get a preferential 5G rate and raised concerns about the FRAND terms of the patent pool. While it was dismissed because the court did not find serious issues with Avanci or InterDigital, Tesla also failed to establish a sufficient legal basis.

²³ This number might be even higher because there are no vehicle sales data of Iseki, Kobelco, Saab and Yanmar.

In the other two ongoing cases, Intellectual Ventures is suing Volvo (Waldrop, 2023), an Avanci licensee, and Tesla (Siegmond, 2024) for various patent infringements at the Western Texas District Court. Appendix 5 provides an overview of the relevant court cases.

5 Discussion

Patent pools play a critical role in navigating complex intellectual property licensing ecosystems of technology-intensive industries. They provide a single point of negotiation for multiple licensors and licensees. This thesis provides a comprehensive analysis of the Avanci 5G pool, focusing on participation trends, SEP and licensee coverage, and revenue generation.

This section discusses the key findings, examines their theoretical and practical implications, and compares them to the existing literature. It also highlights the limitations of this study and offers recommendations for future research.

I collect the relevant data on the participating members and extract and prepare the ETSI database to retrieve all declared SEPs at patent- and patent family level. I calculate the SEP coverage with the share of SEPs included in the Avanci pool relative to the total number of SEPs declared to ETSI. Furthermore, I estimate the licensee coverage with a list of 129 global car manufacturers and use the licensees' unit sales to project the total revenues of the Avanci 5G pool. These steps lead to several relevant findings that can be interpreted and compared with the literature.

My first result highlights the extending participation of patent owners and OEMs in the Avanci 5G pool. The continuous growth of the pool from August 2023 to August 2024 underscores the rising importance of patent pools for SEP licensing within the IoT, particularly the technology-intensive automotive industry. This attractiveness for both parties may result from the various benefits patent pools offer, ranging from lower transaction costs to reduced litigation risks. Moreover, this trend underscores a shift towards more collaborative innovation and shared resources with potential network effects in IPR management.

Furthermore, as the Avanci pool licenses multiple OEMs, it enables a more uniform and rapid implementation of the 5G technology within the industry. Avanci's strategy to engage in the IoT and 5G rollout matches the technology's remarkable development and impact highlighted by the Statista (2024b) report and Lanctot et al. (2023, pp. 4–16).

The overall participation developments align with the increasing significance of standardization, SEPs and patent pools, especially through the emergence of 5G, mentioned by the European Commission (2024b) and Lanctot et al. (2023, pp. 4–16). The need to handle the complexities of the licensing ecosystem, as illustrated by Pohlmann (2017), also support the interest in joining the Avanci pool.

Despite the general increase in participation, the analysis reveals a critical discrepancy in the time-to-license assessment among members. While most licensors joined the

pool immediately at its inception, it took considerably longer for the licensees to join, with only one initial participant. This suggests different motivations and barriers for the members to join. On the one hand, licensors may prefer to join quickly to monetize their patents, cover R&D costs and promote broad technology adoption, aligning with the objectives mentioned by Dewatripont and Legros (2013, p. 928). Licensees, on the other hand, might take a more cautious approach due to cost considerations. They may weigh the benefits of joining the pool against negotiating individual bilateral licensing agreements with the patent owners individually. Market readiness and other aspects of the company's strategic planning, such as product launch cycles, may also be reasons for later participation.

The impact of major licensor joiners like OPPO or Intel, that hold thousands of 2G-5G SEPs, is questionable. While their participation enhances the pool's portfolio and patent coverage, it also strengthens the bargaining power and dominant position of Avanci. Smaller and later joiners could experience less favorable terms and decreased bargaining power. In fact, as already done for the 4G pool in 2022, Avanci may argue with a higher value proposition for vehicle manufacturers and increase the pool's royalty rate even further. This might result in higher vehicle production costs and end-product prices. Regarding the current royalty rate, it is important to note that most licensees joined after the royalty rate increase on February 16, 2024. However, the "other conditions" (Avanci, 2024f) applicable to later entrants, depend on the circumstances and indicate that not all licensees who joined after the increase have to pay the higher rate.

The late adoption by OEMs may be consistent with the continued resistance to the Avanci 5G pool. Six major automotive groups issued a letter to express the concerns about the lack of transparency and FRAND conditions (ACEA, CLEPA, CEMA, CECE, EGME, & FEM, 2024). A second letter from the Chinese State Administration for Market Regulation (2024) indicates potential disadvantages against the dominant pool and calls for monopoly risk assessments related to its licensing practices. In addition to the letters, the formation of alliances like the automotive LNG (Bundeskartellamt, 2024) reflects the manufacturers' perceived urge to counter balance Avanci's negotiation power.

Additionally, it is evident that Avanci only licenses to end-product manufacturers and not to component suppliers. This allows them to maintain high royalty rates due to the higher profit margins of OEMs. The literature outlines several risks regarding the competitiveness and FRAND compliance of this practice (European Commission 2017; Nazzini 2017, p. 21). Disputes over whether manufacturers or suppliers should license a technology, as seen in the Daimler vs. Nokia case (Raturi, 2021), might harm licensee participation. Both parties want the other to bear the licensing costs, but nothing has yet been published about the potential of sharing them.

My second result addresses the first part of the research question and demonstrates the increasing SEP coverage of the Avanci 5G pool at patent- and patent family level. Since

the pool's inception, the coverage increased to 86% at patent level and 90% at patent family level. This extensive coverage strengthens the role of Avanci as a "one-stop shop" for 2G-5G technology licensing within the connected vehicle industry. The pool enhances efficient licensing by reducing the need for multiple bilateral negotiations and providing a broad patent portfolio that aims to foster technology implementation. These benefits are attractive for licensors and licensees and might make Avanci "inevitable".

However, this raises a critical question: Will Avanci's coverage lead to a "lock-in" effect, making OEMs and patent owners dependent and hindering bilateral agreements and other licensing models to emerge? With its expanding coverage, the pool administrator might have the negotiation power to justify higher licensing rates and achieve more favorable terms and conditions. Furthermore, other licensing models might struggle to compete as they will not be able to offer a similar coverage. Avanci has the potential to become the default licensing option for OEMs and patent owners, which reduces their motivation to explore alternatives or negotiate individually. This aligns with the anti-competitive concerns raised by the SEPs Expert Group (2021, p. 27) and Chinese State Administration for Market Regulation (2024). If Avanci maintains its approach of licensing only end-product manufacturers, it will also force OEMs and suppliers to agree on shared licensing costs to resolve the previously mentioned financial disputes in the long term. To avoid legal challenges around FRAND access to the technologies, the pool should ensure that its practices do not restrict competition or innovation within the automotive licensing ecosystem.

The questions brought up by ACEA, CLEPA, CEMA, CECE, EGME, & FEM (2024, pp. 2–3) provide a good starting point for further discussion. They question the essentiality checks of the patents included and seek a justification for the 60% royalty rate increase compared to the 4G pool. Although Avanci (2024f) addresses some issues in their Q&A, the answers are general and lack transparent and detailed information on these aspects. Essentiality checks are particularly important as the European Commission (2023a, p. 25) stresses that only 20-30% of declared SEPs are actually essential, with only 10-20% for 5G technology.

In the interview with Jiang (2024), Avanci President Laurie Fitzgerald explained that the pool's conditions were established through input from multiple stakeholders on "what set of licensing terms they could agree to". She also mentioned the platform costs and "the value that cellular connectivity is going to bring to a 5G connected vehicle" as contribution factors for the royalty rate. This approach does not directly align with the comparable license or top-down approach outlined by Bekkers et al. (2022, p. 5). Instead, it rather focuses on the perceived value and stakeholder consensus.

Given that many members of the automotive groups who signed the letter of complaint already hold an Avanci 5G license and may have provided input during the pool's creation, it is questionable where these concerns come from. That said, literature also states that SEP licensing frequently leads to disputes because FRAND commitments are "inher-

ently vague" Geradin (2020, p. 29).

The letter of complaint could significantly impact the role and perception of lobbying in SEP licensing. Internal disputes might become more visible to the public and bring up questions on how parties behave in private negotiations compared to public statements. However, the letter can also be seen as a mechanism that ensures order and transparency within the industry. This might establish a precedent for groups in other industries to engage in more collaborative lobbying. The recently approved automotive LNG (Bundeskartellamt, 2024) will be an important aspect for that as well. OEMs have realized that they need to collaborate and combine their strengths to compete against influential patent pools on the licensor side.

For the second finding, it is important to note that there is an unproven essentiality verification of the SEPs declared to ETSI. This could lead to an overestimation of the patent coverage due to "over-declaration" by patent holders.

My third result presents the growing licensee coverage of the Avanci 5G pool and addresses the second part of the research question. The finding shows the notably different geographic distribution of the Avanci licensees compared to the 129 global car manufacturers. The low participation of only four Asian OEMs and the absence of Chinese and Japanese ones is striking. In contrast, Europe and the USA have much higher participation rates, with around 40% and 55%, respectively.

The skewed geographic distribution may reflect regional differences in IPR strategies and patent pool participation. The lack of interest of major Chinese and Japanese vehicle manufacturers suggests broader geopolitical and economic influences. For Avanci, the absence of numerous major OEMs creates a market gap. Understanding regional participation is crucial to reach as many licensees as possible and fully capitalize on the pool's growth.

Avanci might struggle to attract Chinese licensees because they follow another licensing approach, as the absence of them is also observable in the Avanci 4G pool (Avanci, 2024a). Given that Counterpoint (2024a) expects China to lead the connected car market, followed by the USA, Japan and Germany, it is particularly important for the pool administrator to tackle this issue. This could include addressing specific concerns that Chinese OEMs have, ranging from dependencies on western-controlled patent pools to anti-competitive practices expressed by the letter of the Chinese State Administration for Market Regulation (2024). The letter seeks a fair licensing market and urges the pool to monitor monopoly risks. Chun (2024) illustrates that failure to do so could lead to potential penalties or a continued lack of market share in this critical market. While one might think that Avanci's focus and practices are regionally biased, it is important to note that their licensors are more equally distributed across the three continents, with the majority in Asia.

In addition to the geographic coverage, the estimated revenue coverage of the Avanci licensees shows substantial growth since the pool's inception. The coverage is expected

to rise from 4.9% to 45.2% of the global car market revenues, driven by an extensive increase in the cumulative projected revenues of Avanci's licensees for 2024. While major OEMs such as BMW, Hyundai, General Motors, and Volkswagen caused notable coverage jumps, global players like Toyota, Honda, Nissan, BYD, and Tesla have not yet joined the pool.

The rapid increment over the one-year period suggests that the Avanci 5G pool is becoming central to the automotive industry. This would align with the various financial and legal benefits a patent pool offers, as elaborated on by Dequiedt and Versaevél (2013, pp. 59–69). For the OEMs, participating in efficient licensing agreements is a key driver of technological success. Nevertheless, major OEMs who decided not to join may seek more favorable terms to their specific needs and want to maintain control over their licensing partners and costs. Joining the pool could mean to agree on the same conditions as their competitors. However, the pool's growing SEP coverage and the resulting efficiency benefits are likely to increase the incentives to join.

While Precedence Research (2024) estimates that 35% of the connected car market are located in Asia, only 13% of the projected revenues of the current Avanci members will be in this region. This underscores the significant underrepresentation of Asian OEMs in the pool. If Avanci fails to cover this market, it could miss out on future growth.

My fourth result further reveals the increasing relevance and attraction of the Avanci 5G patent pool. Its extensive revenue jump is accelerated by the rapid expansion in the number of participating licensees since its inception. It is evident that Avanci is generally successful in attracting a broad range of OEMs.

Successful pools with a broad coverage will become unavoidable as licensing negotiations become more complex (Nikolic & Galli, 2021). However, Avanci's extensive revenue growth emphasizes that regulators need to ensure competition, aligning with the careful management to maintain a balanced ecosystem stressed by European Commission (2023b, pp. 1–3).

That said, I am not able to identify the individual rates of the licensees who joined the pool after the price increase and therefore only use two scenarios for the pool's revenue calculation. Assuming a 66% share of connected car revenues aligns with the forecast by Precedence Research (2024). However, this estimate could be biased, and the actual share might be even higher for Avanci's OEMs who demonstrate an above-average emphasis on connectivity through their pool participation.

My last result highlights the absence of legal cases with Avanci licensors acting as plaintiffs. This implies effective licensing terms and litigation risk reduction. As a result, the licensing environment of the Avanci 5G pool appears more secure, stable and predictable not only for potential entrants but also regulators and legal bodies. This security further enhances Avanci's position and reputation within the industry. However, the pool must be aware of future legal risks and FRAND compliance. Outcomes of key cases can impact negotiations and litigation strategies.

The recently dismissed case between Tesla and InterDigital and Avanci is of special interest. The court's decision to reject Tesla's concerns on Avanci's FRAND terms demonstrates the position of the pool (Müller, 2024c). It appears that courts may be hesitant to interfere with Avanci's established licensing model. Additionally, the dismissal indicates the limited ability of OEMs to negotiate alternative licensing conditions. However, the issue of whether courts can impose FRAND terms for patent pools remains unresolved. This outcome might prevent individual licensees from challenging the pool but may encourage them to create other counter pools to compete.

In addition to my results, there are other aspects that need to be discussed in the context of the impact of regulatory developments and new strategic positions in the automotive SEP licensing landscape.

The proposed EU SEP regulations published by the European Commission (2023b) and the UK SEPs Resource Hub promoted by the UK Government (2024) highlight two distinctly different approaches. The EU's interventionist strategy seeks a regulatory framework to address transparency and FRAND concerns. This indicates an effort to prevent market abuse and ensure fair SEP licensing. However, EU's framework could lead to stricter oversights of SEP licensing, which extends negotiation processes and reduces flexibility. Companies would therefore need to invest in legal and compliance resources to navigate the new regulations.

In contrast, the UK aims to provide a centralized resource hub which assists UK businesses in navigating the complex SEP licensing ecosystem. The approach promotes self-regulation and market-driven solutions. It will also make it easier for unfamiliar companies to access and understand information related to SEPs. Thereby, the UK lowers the entry barriers and encourage a market, where informed players can negotiate more effectively. That could lead to a dominant position of more established companies. However, the UK resource hub's effectiveness will be limited as companies might still face challenges when dealing with different jurisdictions.

It is questionable which approach better balances the interests of licensors and licensees while fostering technological innovation and ensuring fair competition. Depending on the performance of the respective markets, these approaches might set a precedent for other regions. However, different regulations create a fragmented environment where companies like Avanci must handle different rules and expectations depending on the region.

Although Avanci is headquartered in the USA, its members also operate in the EU and UK. Within the EU, Avanci might need to increase operational oversight and slow down some processes to ensure that its practices align with the new regulations. These new regulations could for example force them to also license component suppliers. As the UK approach allows more flexibility, Avanci might favor it. The pool's approach to incorporate feedback from various stakeholders (Jiang, 2024) and creating a "market-driven pricing" model (Avanci, 2024f) can already be linked to the UK's ap-

proach.

The last important topic are the shifts in how OEMs are approaching IPRs and licensing strategies. We can see this in Toyota's recent acquisition of SEPs from OPPO (Müller, 2024d) and the formation of the automotive LNG (Bundeskartellamt, 2024).

On the one hand, the move by Toyota might be the response to increasing complexities and costs of SEP licensing. With the acquisition, the vehicle manufacturer enhances its portfolio and bargaining power. This step towards autonomy allows the use of the acquired patents in cross-licensing deals to reduce dependencies and costs. Regarding patent pool participation, this means that the OEM could enter as a licensor and licensee at the same time.²⁴ These advantages might encourage other OEMs to approach a similar strategy.

On the other hand, the automotive LNG tries to push back against the risk of high licensing costs and unfavorable terms of dominant pools like Avanci. As vehicles become more technology-intensive, this can significantly impact the profitability of OEMs. Traditionally, Avanci seemed to be driving the SEP licensing terms within the automotive industry. The counter pool might introduce a new dynamic that could rebalance the automotive SEP ecosystem. However, the success of the LNG will depend on its ability to attract members and navigate regulatory, financial and transparency challenges.

Another important part of this section are the limitations of this research. In general, the focus only on the Avanci 5G patent pool illustrates a methodological constraint. As other industries and markets may have different patent pools and licensing structures, my results should be transferred to other contexts with caution. The findings are applicable to Avanci and the automotive industry, but other sectors might not experience the same outcomes. Furthermore, it is important to keep in mind that this study analyzed the pool until August 31, 2024. The automotive industry has already evolved rapidly during the one-year period since the pool's inception, which indicates a high probability of significant further developments that need to be evaluated when reviewing the outcomes of this thesis.

As a result, I have some suggestions for future research. If the scope and available resources allow, I recommend improving the completeness and accuracy of the dataset to address some of the limitations of my research. Regarding the Avanci pool, it would be interesting to understand, why major OEMs refuse to join. Also, the industry's perception of the impact of new trends, including the remaining resistance, the emergence of the automotive LNG and proposed regulatory frameworks, could be valuable. However, this should also be compared with the dynamics of patent pools in other industries.

²⁴ Hyundai and Kia recently joined the Versatile Video Coding patent pool as licensors, becoming the first OEMs to participate as licensors in a major patent pool (Morris, 2024).

6 Conclusion

The emergence of new technologies that heavily rely on standardization significantly increases the complexity of SEP licensing, highlights the importance of patent pools and underscores the need to evaluate their participation dynamics and operational achievements.

This thesis analyzes the participation trends in the Avanci 5G vehicle pool, focusing on the development of the pool's patent and licensee coverages since its inception on August 16, 2023. The study uses data on the pool members and relevant SEPs declared to ETSI to estimate the pool's coverages and total revenue.

Increased participation by patent holders and OEMs has led to a substantial growth in both coverages over the past year. This illustrates the extensive significance of the pool in the technology-intensive automotive industry, resulting in a notable growth in estimated revenue for 2024. However, the pool's inability to attract major Asian OEMs, particularly from China, suggests their favor for other licensing strategies. Also, perceived anti-competitive risks, such as "lock-in" effects and the restriction of bilateral agreements, could be caused by the dominance of the pool.

Therefore, future research should include in-depth case studies of large companies that have not joined the pool to understand alternative licensing strategies and regional differences. Furthermore, the impact of geopolitical dynamics on patent pool participation and the SEP licensing landscape needs to be explored. Expert opinion gathered through industry and academic interviews could further support this. Given this study's focus on the automotive industry, comparative research across different sectors would help to understand the effectiveness, challenges, and impact of patent pools more broadly.

Looking ahead, emerging technologies, evolving regulatory frameworks, and new licensing strategies will continue to reshape the licensing ecosystem. Stakeholders must navigate these challenges collaboratively. Pool administrators need transparent and flexible licensing terms to attract a wider range of participants and adapt to new market conditions. The long-term success of a pool will depend on how well it can balance the interests of licensors and licensees without abusing its power. Regulators must promote an approach that encourages competition and innovation without creating overwhelming regulatory burden. An adaptive regulatory framework that evolves with technological advancements could be the solution. Therefore, the formation of working groups that include all stakeholders could benefit the discussion and negotiation of specific terms.

References

- ACEA, CLEPA, CEMA, CECE, EGME, & FEM. (2024). Multi-Association Letter to Avanci. https://www.acea.auto/files/Multi-Association_Letter_to_Avanci.pdf
- Avanci. (2023a). BMW Group joins Avanci 5G Connected Vehicle Licensing Program. <https://www.avanci.com/2023/09/18/bmw-group-joins-avanci-5g-connected-vehicle-licensing-program/>

- Avanci. (2023b). Momentum continues for Avanci and its independent, global licensing solutions as Hyundai and Kia sign 5G vehicle agreements. <https://www.avanci.com/2023/11/07/momentum-continues-for-avanci-and-its-independent-global-licensing-solutions-as-hyundai-and-kia-sign-5g-vehicle-agreements/>
- Avanci. (2024a). Avanci 4G Vehicle. <https://www.avanci.com/vehicle/4gvehicle/>
- Avanci. (2024b). Avanci 5G Vehicle. <https://web.archive.org/web/20240826071131/https://www.avanci.com/vehicle/5gvehicle/>
- Avanci. (2024c). Avanci 5G Vehicle. <https://www.avanci.com/vehicle/5gvehicle/>
- Avanci. (2024d). Avanci Announces 5G Vehicle License Agreement with General Motors. <https://www.avanci.com/2024/02/13/avanci-announces-5g-vehicle-license-agreement-with-general-motors/>
- Avanci. (2024e). Avanci Launches 5G Connected Vehicle Licensing Program. <https://www.avanci.com/2023/08/16/avanci-launches-5g-connected-vehicle-licensing-program/>
- Avanci. (2024f). Avanci Vehicle. <https://www.avanci.com/vehicle/>
- Avanci. (2024g). Avanci Welcomes the Volkswagen Group to its 5G Vehicle Licensing Program. <https://www.avanci.com/2024/02/20/avanci-welcomes-the-volkswagen-group-to-its-5g-vehicle-licensing-program/>
- Avanci. (2024h). What Is Avanci? <https://www.avanci.com/>
- Barnett, J. M. (2018). Has the Academy Led Patent Law Astray? *Berkeley Technology Law Journal*, 32(5), 1321–1324. <https://doi.org/10.15779/Z388P5V91H>
- Baron, J., & Ménière, Y. (2014). Patent Pools. *Selected Quantitative Studies of Patents in Standards*, 55. <https://doi.org/10.2139/ssrn.2457064>
- Baron, J., & Pohlmann, T. (2018). Mapping standards to patents using declarations of standard-essential patents. *Journal of Economics & Management Strategy*, 27(3), 504–534. <https://doi.org/10.1111/jems.12255>
- Baron, J., & Schmidt, J. (2019). Technological Standardization, Endogenous Productivity and Transitory Dynamics. *Banque de France*, 503, 5. <https://doi.org/10.2139/ssrn.2478707>
- Bekkers, R., Raiteri, E., Martinelli, A., Tur, E. M., & Thumm, N. (2020). Landscape Study of Potentially Essential Patents Disclosed to ETSI. Pilot Study for Essentiality Assessment of Standard Essential Patents. <https://data.europa.eu/doi/10.2760/313626>
- Bekkers, R., Tur, E. M., Henkel, J., van der Vorst, T., Driesse, M., & Contreras, J. L. (2022). Overcoming Inefficiencies in Patent Licensing: A Method to Assess Patent Essentiality for Technical Standards. *Research Policy*, 51(10), 5. <https://doi.org/10.1016/j.respol.2022.104590>
- Bellflamme, P. (2002). Coordination on Formal vs. De Facto Standards: A Dynamic Approach. *European Journal of Political Economy*, 18, 153–176. <https://www.sciencedirect.com/science/article/pii/S0176268001000738?via%3Dihub>
- Blind, K., & Thumm, N. (2004). Interrelation Between Patenting and Standardisation Strategies: Empirical Evidence and Policy Implications. *Research Policy*, 33(10), 1583–1598. <https://doi.org/10.1016/j.respol.2004.08.007>
- Brazier, T. (2024). A Closer Look at the New UKIPO SEP Resource Hub. <https://www.iam-media.com/hub/sepfrand-hub/2023/article/closer-look-the-new-ukipo-sep-resource-hub>
- Bundeskartellamt. (2024). Proposed creation of a framework for negotiating licence agreements for standard essential patents (SEPs) through an “Automotive Licensing Negotiation Group” (ALNG). https://www.bundeskartellamt.de/SharedDocs/Publikation/EN/Others/B4_136_23_Vorsitzendenschreiben.html?nn=52004
- Chiesa, V., Manzini, R., & Toletti, G. (2002). Standard-setting processes: evidence from two case studies. *R&D Management*, 32, 431–450. <https://onlinelibrary.wiley.com/doi/10.1111/1467-9310.00274>
- Chun, Z. (2024). A Deep Dive into China’s Three-Letters-One-Notice System as Compliance Challenges Emerge for Patent Pools. <https://www.iam-media.com/hub/sepfrand-hub/2023/article/deep-dive-chinas-three-letters-one-notice-system-compliance-challenges-emerge-patent-pools>
- Cohen, L., Gurun, U., & Kominers, S. (2018). Patent Trolls: Evidence from Targeted Firms. <http://dx.doi.org/10.2139/ssrn.2464303>
- Counterpoint. (2024a). Global Connected Car Sales to Exceed 500 Million in 2024-2030. <https://www.counterpointresearch.com/insights/global-connected-car-sales-to-exceed-500-million-in-2024-2030/>
- Counterpoint. (2024b). Two-thirds of Cars Sold in Q3 2023 Featured Embedded Connectivity. <https://www.counterpointresearch.com/insights/global-connected-car-sales-q3-2023/>
- David, P., & Greenstein, S. (1990). The Economics of Compatibility Standards: An Introduction to Recent Research. *Economics of Innovation and New Technology*, 3–41. <https://doi.org/10.1080/10438599000000002>
- Dequiedt, V., & Versaavel, B. (2013). Patent Pools and dynamic R&D incentives. *International Review of Law and Economics*, 36, 59–69. <https://doi.org/10.1016/j.irl.2013.04.009>
- Dewatripont, M., & Legros, P. (2013). “Essential” patents, FRAND royalties and technological standards. *The Journal of Industrial Economics*, 61(4), 928. <https://doi.org/10.1111/joie.12033>
- Dini, G. (2024). Aggregator-Arranged Video Patent Deal Brings Licensing Efficiency. <https://www.sisvel.com/news/aggregator-arranged-video-patent-deal-brings-licensing-efficiency/>
- ETSI. (2024a). Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards. <https://www.etsi.org/standards-search?search=SR+000+314#page=1&search=SR%20000%20314&title=1&etsiNumber=1&content=0&version=0&onApproval=1&published=1&withdrawn=1&historical=0&isCurrent=1&superseded=1&startDate=1988-01-15&endDate=2024-07-31&harmonized=0&keyword=&TB=&stdType=&frequency=&mandate=&collection=&sort=1>
- ETSI. (2024b). Intellectual Property Rights Policy and IPR Online Database. <https://www.etsi.org/intellectual-property-rights>
- ETSI. (2024c). Why Standards. <https://www.etsi.org/standards/why-standards?jij=1721032782036>
- European Commission. (2014). Patents and Standards – A Modern Framework for IPR-Based Standardization - Final Report, 67–68. <https://data.europa.eu/doi/10.2769/90861>
- European Commission. (2017). Setting out the EU approach to Standard Essential Patents. <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52017DC0712&from=EN>
- European Commission. (2023a). Economic impact assessment on Standard Essential Patents (SEPs) - Support study. <https://data.europa.eu/doi/10.2873/19262>
- European Commission. (2023b). Regulation of the European Parliament and of the Council on Standard Essential Patents and Amending Regulation. https://single-market-economy.ec.europa.eu/publications/com2023232-proposal-regulation-standard-essential-patents_en
- European Commission. (2024a). Intellectual Property – New Framework for Standard-Essential Patents - Feedback and Statistics. https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13109-Intellectual-property-new-framework-for-standard-essential-patents/feedback_en?p_id=28414115
- European Commission. (2024b). Standard Essential Patents. https://single-market-economy.ec.europa.eu/industry/strategy/intellectual-property/patent-protection-eu/standard-essential-patents_en
- Fancourt, J. (2023). Tesla vs. InterDigital and Avanci. <https://www.baillii.org/ew/cases/EWHC/Ch/2024/1815.pdf>
- Geradin, D. (2020). SEP Licensing after Two Decades of Legal Wrangling: Some Issues Solved, Many Still to Address. *Antitrust Chronicle*, 3, 25–38. <https://www.competitionpolicyinternational.com/category/winter-2020-volume-3-number-2/>
- Geradin, D., & Katsifis, D. (2021). End-product- vs Component-level Licensing of Standard Essential Patents in the Internet of Things Context. <https://doi.org/10.2139/ssrn.3848532>
- Houldsworth, A. (2024). Sisvel and RPX strike major video coding patent deal. <https://www.iam-media.com/article/sisvel-and-rpx-strike-major-video-coding-patent-deal>
- Jiang, J. (2024). Dialogue with Avanci Vehicle President Laurie Fitzgerald: Avanci, an Independent Platform Provides a Licensing Option. <http://www.chinaiptoday.com/post.html?id=2103>

- Kanevskaia, O. (2020). The Need for Multi-disciplinary Education About Standardization. *Sustainable Development*, 161–178. https://doi.org/10.1007/978-3-030-28715-3_10
- Khanh, Q. V., Hoai, N. V., Manh, L. D., Le, A. N., & Jeon, G. (2022). Wireless Communication Technologies for IoT in 5G: Vision, Applications, and Challenges. *Wireless Communications and Mobile Computing*, 1–3. <https://doi.org/10.1155/2022/3229294>
- Klos, M. (2020). Federal Cartel Office Issues Opinion in Connected Cars Case. <https://www.juve-patent.com/cases/federal-cartel-office-issues-opinion-in-connected-cars-case/>
- Koh, L. (2019). Continental Automotive Systems v. Avanci. <https://casetext.com/case/contl-auto-sys-v-avanci-llc-4>
- Lanctot, R., Kendall, P., & Koehler, A. (2023). 5G Connected Cars: A Transformative Value Proposition. *Tech Insights*, 4–16. <https://www.avanci.com/5g-report/>
- Lavenue, L. M., Myles, J. M., & Evans, R. (2023). IP Transactions, Professional Perspective - Future of SEP Licensing in the Auto Industry. *Bloomberg Law*. <https://www.finnegan.com/en/insights/articles/ip-transactions-professional-perspective-future-of-sep-licensing-in-the-auto-industry.html>
- Lemley, M., & Shapiro, C. (2013). A Simple Approach to Setting Reasonable Royalties for Standard-Essential Patents. *Berkeley Technology Law Journal*, 28, 1137. <https://doi.org/10.2139/ssrn.2243026>
- Lerner, J., & Tirole, J. (2015). Standard-Essential Patents. *Journal of Political Economy*, 123(3), 547–586. <https://doi.org/10.1086/680995>
- Lovatt, S. (2023). Intel Signs Up as Licensor to Avanci 4G and 5G Connected Car Programmes. <https://www.iam-media.com/article/intel-signs-licensor-avanci-4g-and-5g-connected-car-programmes>
- Ma, M. (2024). OPPO joins Avanci 5G. https://michael7924.substack.com/p/oppo-joins-avanci-5g?r=1215b8&utm_campaign=post&utm_medium=web&triedRedirect=true
- Martinez, J. (2019). FRAND as Access to All versus License to All. *Journal of Intellectual Property Law & Practice*, 14(8), 649. <https://doi.org/10.1093/jiplp/jpz075>
- Morris, A. (2024). Hyundai Makes Move in Goal to Be Future SEP Licensor. <https://www.iam-media.com/article/hyundai-makes-move-in-goal-be-future-sep-licensor>
- Mossoff, A. (2023). Via Licensing, MPEG-LA Merger Shows Patent Pools Have Come of Age. <https://www.iam-media.com/article/licensing-mpeg-la-merger-shows-patent-pools-have-come-of-age>
- Muller, F. (2022). Frustrated over Avanci patent pool's market penetration, critics ask DOJ to revisit Business Review Letter—but their disagreement with German patent law is no U.S. antitrust problem. *Foss Patents*. <http://www.fosspatents.com/2022/10/frustrated-over-avanci-patent-pools.html>
- Muller, F. (2023). New Mercedes-Benz statement: despite Avanci 5G license, EU should enact regulation on standard-essential patents in accordance with DG GROW's legislative proposal. *Foss Patents*. <http://www.fosspatents.com/2023/08/new-mercedes-benz-statement-despite.html>
- Müller, F. (2024a). About ip fray. <https://ipfray.com/about/>
- Müller, F. (2024b). Philips gets 5G SEPs from OPPO, probably under recent settlement agreement and following OPPO's recent Toyota deal. <https://ipfray.com/philips-gets-5g-seps-from-oppo-probably-under-recent-settlement-agreement-and-following-oppo-recent-toyota-deal/>
- Müller, F. (2024c). Tesla tells UK court it has Avanci 4G license but wants preferential 5G rate, estimates Avanci's coverage at 80%. <https://ipfray.com/tesla-tells-uk-court-it-has-avanci-4g-license-but-wants-preferential-5g-rate-estimates-avancis-coverage-at-80/>
- Müller, F. (2024d). Toyota acquired dozens of 5G SEPs from OPPO to equip itself for cross-licensing and countersuits. <https://ipfray.com/toyota-acquired-dozens-of-5g-seps-from-oppo-to-equip-itself-for-cross-licensing-and-countersuits/>
- Nazzini, R. (2017). Level Discrimination and FRAND Commitments under EU Competition Law. *World Competition*, 40(2), 21. <https://doi.org/10.54648/woco2017015>
- Nikolic, I., & Galli, N. (2021). A Look Into the IoT Future of SEP Licensing. *CPI IP Columns*, 1–8. <https://ssrn.com/abstract=3848041>
- Nikolic, I., & Galli, N. (2022). Patent Pools in 5G: The principles for facilitating pool licensing. *Telecommunications Policy*, 46(4). <https://doi.org/10.1016/j.telpol.2021.102287>
- OECD. (2019). Licensing of IP Rights and Competition Law. *OECD Roundtables on Competition Policy Papers*, 230, 24–36. <https://doi.org/10.1787/6a74221e-en>
- Pohlmann, T. (2015). Landscaping Standard-Essential Patents. <https://www.iam-media.com/article/landscaping-standard-essential-patents>
- Pohlmann, T. (2017). Patents and Standards in the Auto Industry. <https://www.iam-media.com/article/patents-and-standards-in-the-auto-industry>
- Pohlmann, T. (2023). Avanci's new 5G Vehicle Program – A One Stop Shop? <https://www.linkedin.com/pulse/avancis-new-5g-vehicle-program-one-stop-shop-tim-pohlmann/>
- Precedence Research. (2024). Connected Cars Market Size, Share, and Trends 2024 to 2034. <https://www.precedenceresearch.com/connected-cars-market>
- Rabbi, N. F. (2020). Introduction to 5G. *Islamic University of Technology*, 1. <http://dx.doi.org/10.13140/RG.2.2.14027.00804>
- Raturi, P. (2021). Limiting SEP Licensing to End Product Manufacturers - Abuse of Dominance? *Oxford Business Law Blog*. <https://blogs.law.ox.ac.uk/business-law-blog/blog/2021/08/limiting-sep-licensing-end-product-manufacturers-exclusion-component>
- Schüll, G. (2024). Bundeskartellamt Allows Cooperation Between Automotive Companies in SEP Licensing. *Cohausz & Florack*. <https://www.cohausz-florack.de/en/blog/article/bundeskartellamt-allows-cooperation-between-automotive-companies-in-sep-licensing/>
- Schwartz, D., & Kesan, J. (2014). Analyzing the Role of Non-Practicing Entities in the Patent System. *Cornell Law Review*, 99(2), 426–456. <https://doi.org/10.2139/ssrn.2117421>
- SEPs Expert Group. (2021). *Contribution to the Debate on SEPs* (tech. rep. No. 27). European Commission. <https://ec.europa.eu/docsroom/documents/45217>
- Shan, G. (2024). Toyota acquires dozens of communications SEPs from OPPO to address patent dilemma of automakers. *Intellectual Property Finance*. https://mp.weixin.qq.com/s/r_zB9beG7y4i2GWBxXHOhg
- Siegmund, M. (2024). Intellectual Ventures vs. Tesla. *Western Texas District Court*. <https://s3.documentcloud.org/documents/24547997/24-04-12-iv-v-tesla-complaint.pdf>
- State Administration for Market Regulation. (2024). The State Administration for Market Regulation Has Legally Reminded and Urged Avanci to Address the Monopoly Risks of Its Patent Pool. https://www.samr.gov.cn/xw/zj/art/2024/art_ec1c9ce3d71a4a5baf853d430a3b5667.html
- Statista. (2020). Share of New Vehicles Shipped Worldwide with Built-In Connectivity in 2020 and 2030. <https://www.statista.com/statistics/1276018/share-of-connected-cars-in-total-new-car-sales-worldwide/>
- Statista. (2022). Connected Vehicle Fleet from 2025 to 2035, by Key Region. <https://www.statista.com/statistics/442529/connected-car-market-size-by-region/>
- Statista. (2023). Selected Farm Machinery Manufacturers Worldwide in FY 2022, Based on Revenue. <https://www.statista.com/statistics/461428/revenue-of-major-farm-machinery-manufacturers-worldwide/>
- Statista. (2024a). Number of Cars Sold Worldwide from 2010 to 2023, with a 2024 Forecast. <https://www.statista.com/statistics/200002/international-car-sales-since-1990/>
- Statista. (2024b). Number of Internet of Things (IoT) Connections Worldwide from 2022 to 2023, with Forecasts from 2024 to 2033. <https://www.statista.com/statistics/1183457/iot-connected-device-s-worldwide/>
- Sterzi, V., Rameshkoumar, J.-P., & Van Der Pol, J. (2020). *Non-practicing entities and transparency in patent ownership in Europe* (tech. rep. No. 4). Bordeaux Economic Working Paper. <https://ideas.repec.org/p/grt/bdxewp/2020-10.html>
- UK Government. (2024). One-Stop SEPs Resource Hub Launched by UK IPO. <https://www.gov.uk/government/news/one-stop-seps-resource-hub-launched-by-uk-ipo>

- Via Licensing Alliance. (2023). Via Licensing and MPEG LA Unite to Form Via Licensing Alliance, the Largest Patent Pool Administrator in the Consumer Electronics Industry. <https://www.via-la.com/via-licensing-and-mpeg-la/>
- Via Licensing Alliance. (2024). About Via LA. <https://www.via-la.com/about-2/>
- Waldrop, J. (2023). Intellectual Ventures vs. Volvo. *Western Texas District Court*. <https://s3.documentcloud.org/documents/23837560/23-06-07-intellectual-ventures-v-volvo-patent-infringement-complaint.pdf>

List of Abbreviations

ETSI European Telecommunications Standards Institute

EU European Union

FRAND Fair, Reasonable and Non-Discriminatory

IoT Internet of Things

IPR Intellectual Property Right

LNG Licensing Negotiation Group

NPE Non-Practicing Entity

OEM Original Equipment Manufacturer

R&D Research & Development

SEP Standard-Essential Patent

SSO Standard-Setting Organization

UK United Kingdom

USA United States of America